Tutorial: Configure replication between two fully connected servers (transactional)

Applies to: ✓ SQL Server (all supported versions)

Transactional replication is a good solution to the problem of moving data between continuously connected servers. By using the Replication Wizard, you can easily configure and administer a replication topology.

This tutorial shows you how to configure a transactional replication topology for continuously connected servers. For more information about how transactional replication works, see the overview of transactional replication.

What you will learn

This tutorial teaches you to publish data from one database to another by using transactional replication.

In this tutorial, you will learn how to:

- Create a publisher via transactional replication.
- Create a subscriber for the transactional publisher.
- Validate the subscription and measure latency.

Prerequisites

This tutorial is for users who are familiar with basic database operations, but who have limited experience with replication. Before you start this tutorial, you must complete Tutorial: Prepare SQL Server for replication.

To complete this tutorial, you need SQL Server, SQL Server Management Studio (SSMS), and an AdventureWorks database:

- At the publisher server (source), install:
  - Any edition of SQL Server, except SQL Server Express or SQL Server Compact. These editions cannot be replication publishers.
  - The **AdventureWorks2012** sample database. To enhance security, the sample databases are not installed by default.

- At the subscriber server (destination), install any edition of SQL Server, except SQL Server Compact. SQL Server Compact cannot be a subscriber in transactional replication.
- Install SQL Server Management Studio.
- Install SQL Server 2017 Developer edition.
- Download the AdventureWorks sample database. For instructions on restoring a database in SSMS, see Restoring a database.

Note

- Replication is not supported on SQL Server instances that are more than two versions apart. For more information, see **Supported SQL Server Versions in Replication Topology**.
- In SQL Server Management Studio, you must connect to the publisher and subscriber by using a login that is a member of the **sysadmin** fixed server role. For more information on this role, see **Server-level roles**.

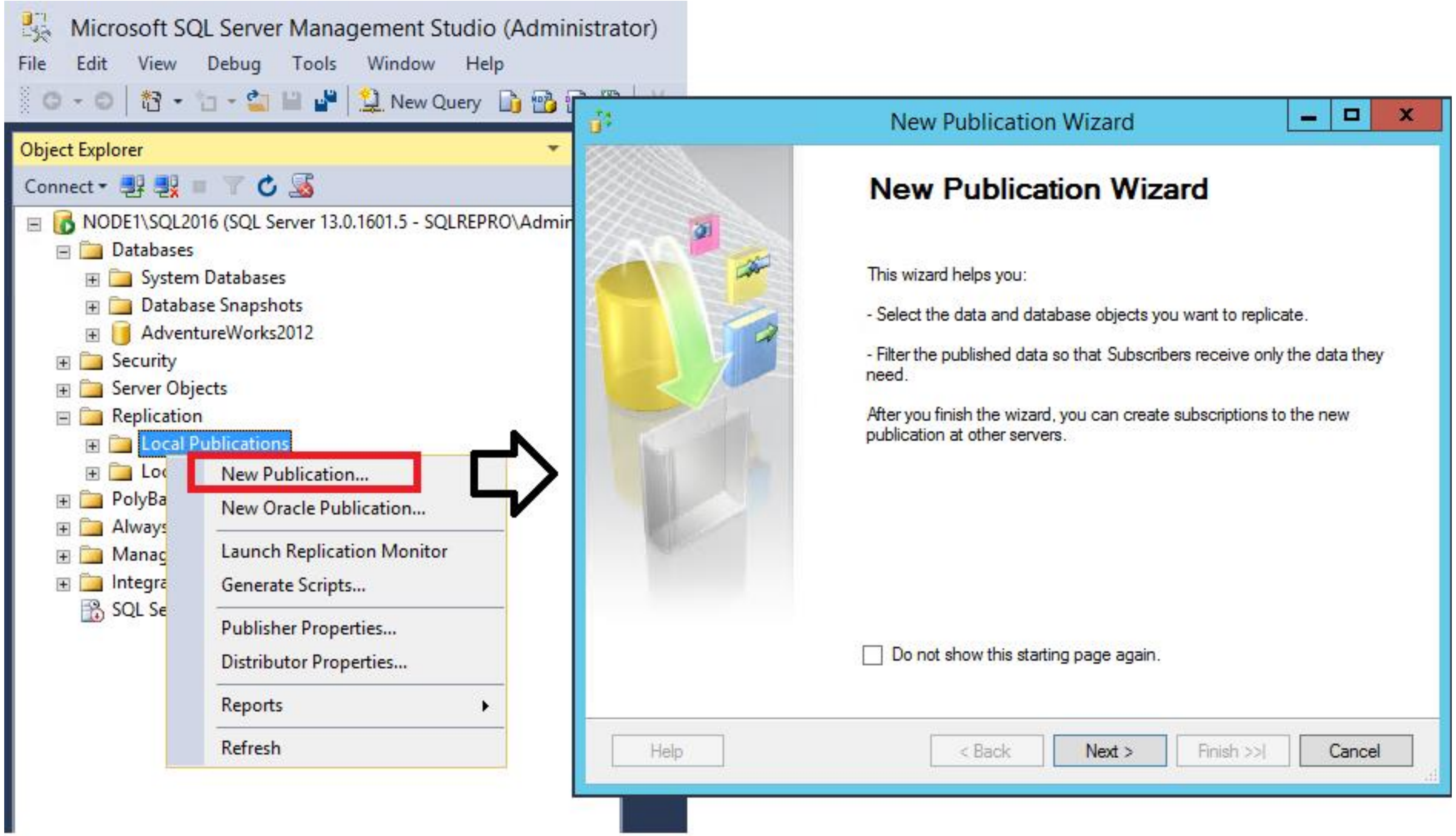
Estimated time to complete this tutorial: 60 minutes

Configure the publisher for transactional replication

In this section, you create a transactional publication by using SQL Server Management Studio to publish a filtered subset of the **Product** table in the **AdventureWorks2012** sample database. You also add the SQL Server login used by the Distribution Agent to the publication access list (PAL).

Create a publication and define articles

1. Connect to the publisher in SQL Server Management Studio, and then expand the server node.
2. Right-click **SQL Server Agent** and select **Start**. The SQL Server Agent should be running before you create the publication. If this step does not start your agent, you'll need to do so manually from SQL Server Configuration Manager.
3. Expand the **Replication** folder, right-click the **Local Publications** folder, and select **New Publication**. This step starts the New Publication Wizard:



New Publication Wizard

This wizard helps you:

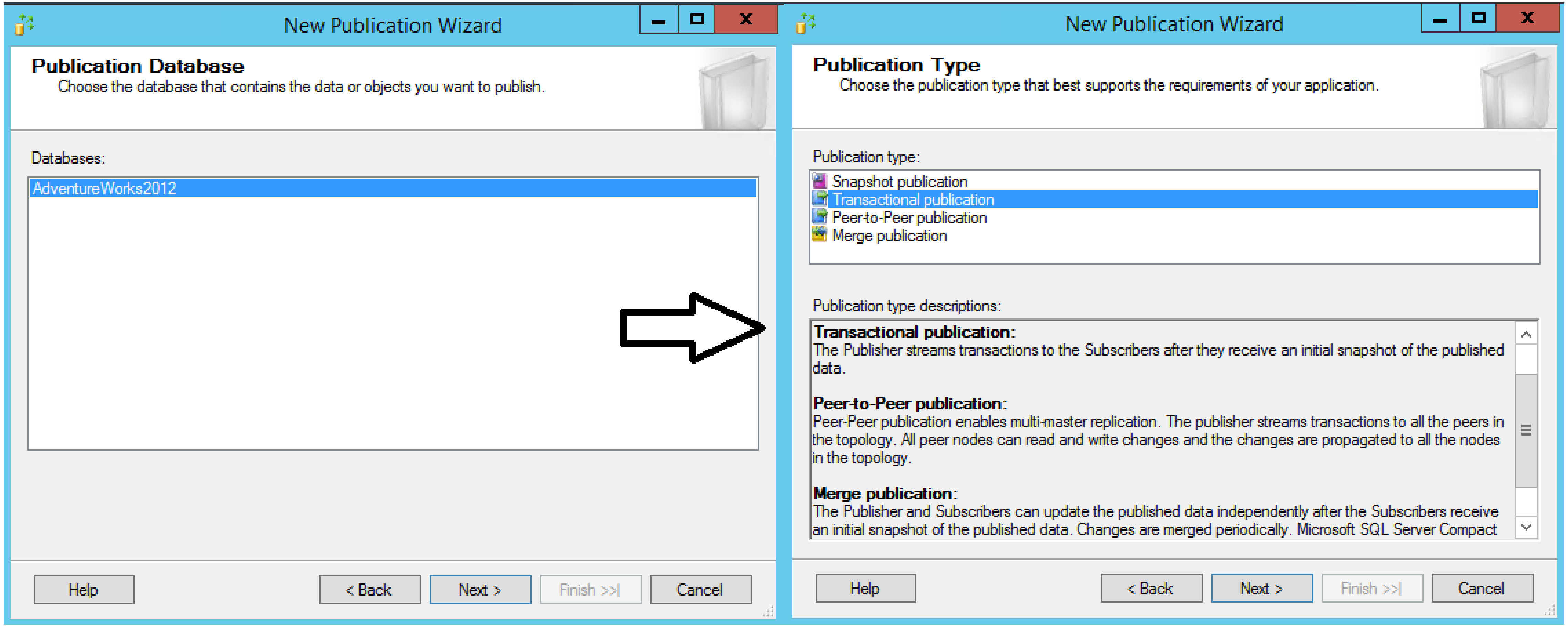
- Select the data and database objects you want to replicate.

- Filter the published data so that Subscribers receive only the data they need.

After you finish the wizard, you can create subscriptions to the new publication at other servers.

□ Do not show this starting page again.

4. On the **Publication Database** page, select **AdventureWorks2012**, and then select **Next**.
5. On the **Publication Type** page, select **Transactional publication**, and then select **Next**:



Publication Database

Choose the database that contains the data or objects you want to publish.

Databases:

AdventureWorks2012

Publication Type

Choose the publication type that best supports the requirements of your application.

Publication type:

- Snapshot publication
- Transactional publication
- Peer-to-Peer publication
- Merge publication

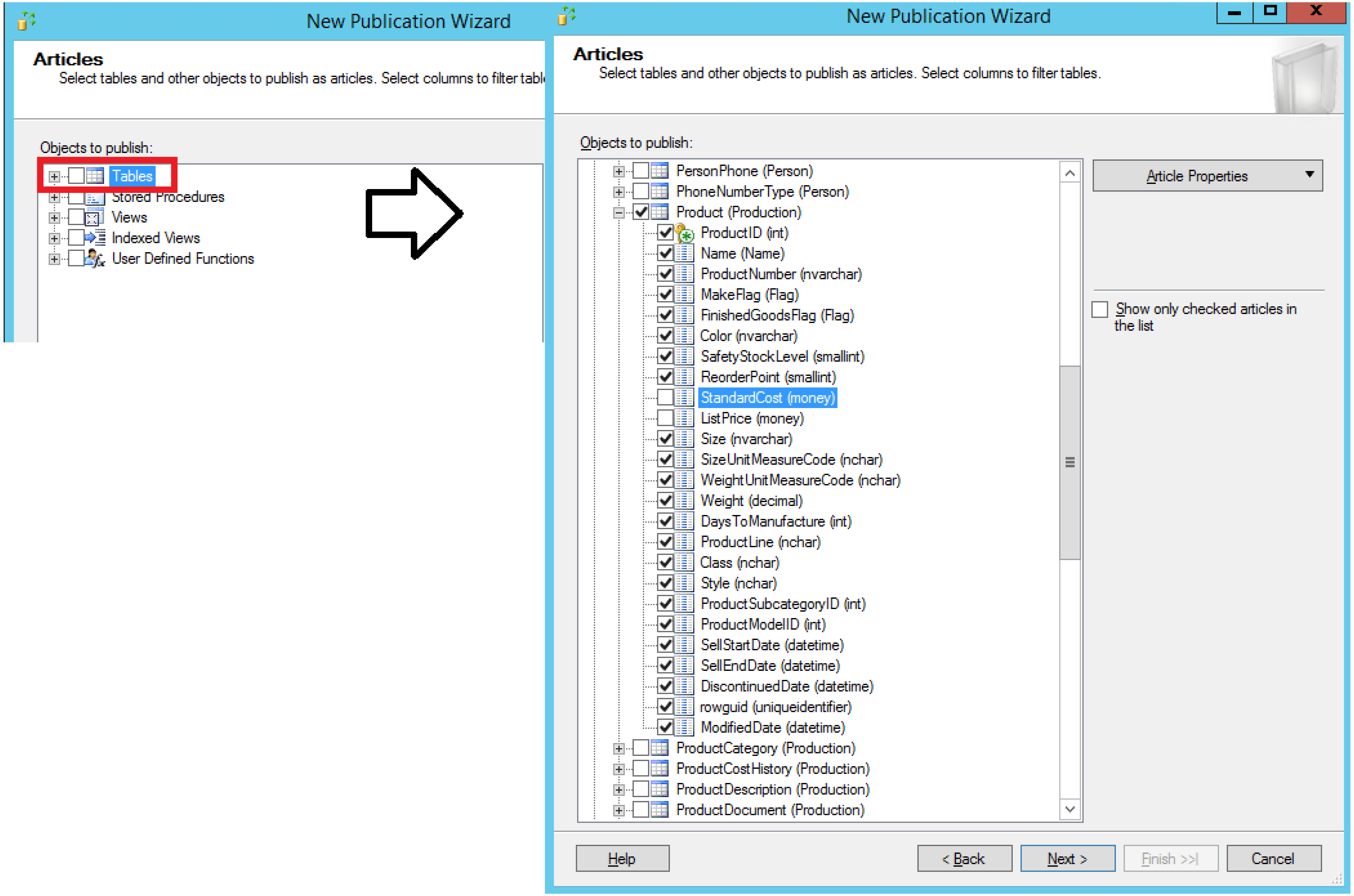
Publication type descriptions:

Transactional publication:
The Publisher streams transactions to the Subscribers after they receive an initial snapshot of the published data.

Peer-to-Peer publication:
Peer-Peer publication enables multi-master replication. The publisher streams transactions to all the peers in the topology. All peer nodes can read and write changes and the changes are propagated to all the nodes in the topology.

Merge publication:
The Publisher and Subscribers can update the published data independently after the Subscribers receive an initial snapshot of the published data. Changes are merged periodically. Microsoft SQL Server Compact

6. On the **Articles** page, expand the **Tables** node and select the **Product** check box. Then expand **Product** and clear the check boxes next to **ListPrice** and **StandardCost**. Select **Next**.



New Publication Wizard

Articles

Select tables and other objects to publish as articles. Select columns to filter tabl

Objects to publish:

- □ Tables
- □ Stored Procedures
- □ Views
- □ Indexed Views
- □ User Defined Functions

New Publication Wizard

Articles

Select tables and other objects to publish as articles. Select columns to filter tables.

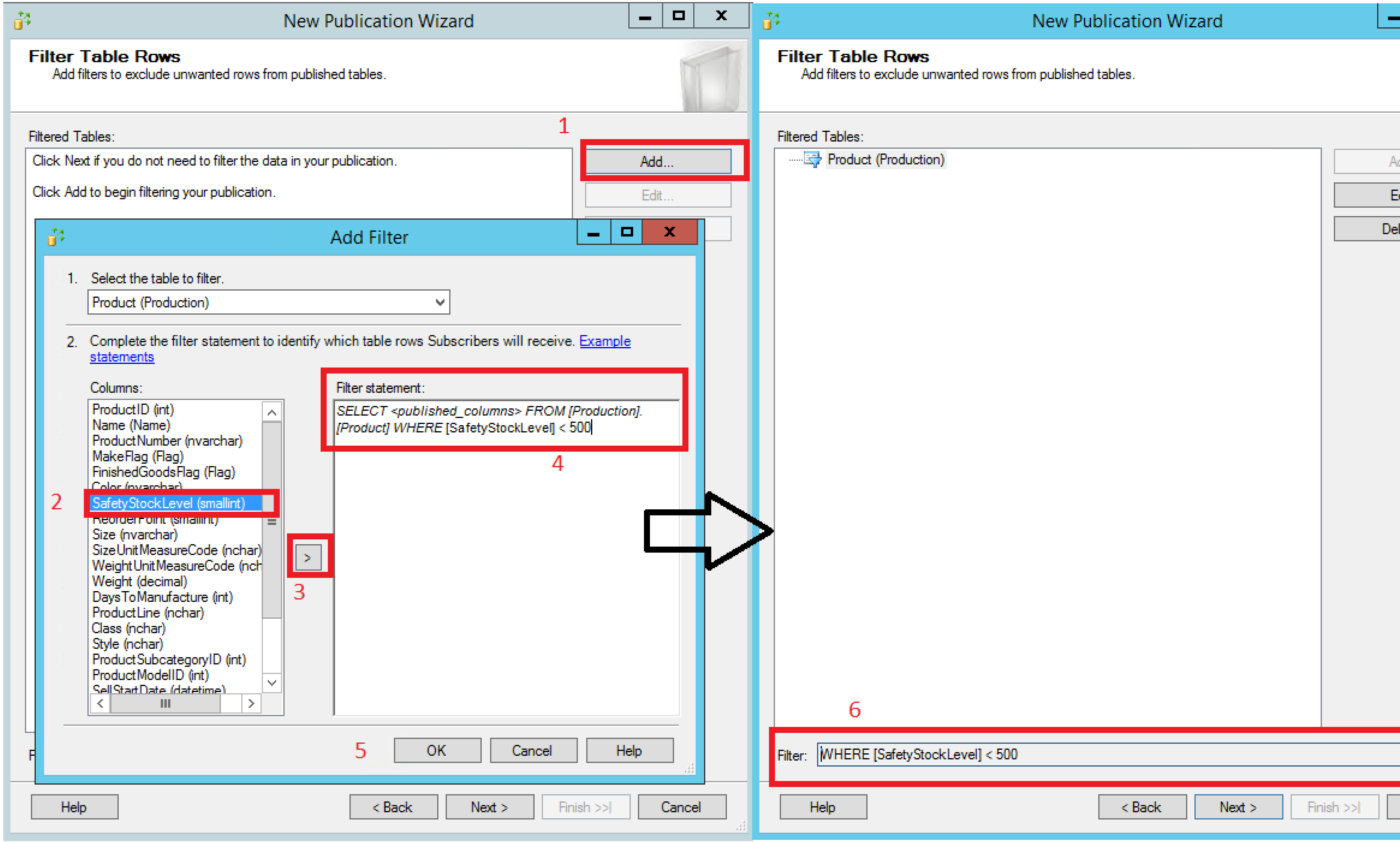
Objects to publish:

- □ PersonPhone (Person)
- □ PhoneNumberType (Person)
- ☑ Product (Production)
  - ☑ ProductID (int)
  - ☑ Name (Name)
  - ☑ ProductNumber (nvarchar)
  - ☑ MakeFlag (Flag)
  - ☑ FinishedGoodsFlag (Flag)
  - ☑ Color (nvarchar)
  - ☑ SafetyStockLevel (smallint)
  - ☑ ReorderPoint (smallint)
  - □ StandardCost (money)
  - □ ListPrice (money)
  - ☑ Size (nvarchar)
  - ☑ SizeUnitMeasureCode (nchar)
  - ☑ WeightUnitMeasureCode (nchar)
  - ☑ Weight (decimal)
  - ☑ DaysToManufacture (int)
  - ☑ ProductLine (nchar)
  - ☑ Class (nchar)
  - ☑ Style (nchar)
  - ☑ ProductSubcategoryID (int)
  - ☑ ProductModelID (int)
  - ☑ SellStartDate (datetime)
  - ☑ SellEndDate (datetime)
  - ☑ DiscontinuedDate (datetime)
  - ☑ rowguid (uniqueidentifier)
  - ☑ ModifiedDate (datetime)
- □ ProductCategory (Production)
- □ ProductCostHistory (Production)
- □ ProductDescription (Production)
- □ ProductDocument (Production)

7. On the **Filter Table Rows** page, select **Add**.
8. In the **Add Filter** dialog box, select the **SafetyStockLevel** column. Select the right arrow to add the column to the filter statement WHERE clause of the filter query. Then manually type in the WHERE clause modifier as follows:

   SQLCopy

   ```
   WHERE [SafetyStockLevel] < 500
   ```



Filter Table Rows
Add filters to exclude unwanted rows from published tables.

Filtered Tables:

Click Next if you do not need to filter the data in your publication.

Click Add to begin filtering your publication.

1. Select the table to filter.
Product (Production)

2. Complete the filter statement to identify which table rows Subscribers will receive. Example statements

Columns:
ProductID (int)
Name (Name)
ProductNumber (nvarchar)
MakeFlag (Flag)
FinishedGoodsFlag (Flag)
Color (nvarchar)
SafetyStockLevel (smallint)
ReorderPoint (smallint)
Size (nvarchar)
SizeUnitMeasureCode (nchar)
WeightUnitMeasureCode (nch
Weight (decimal)
DaysToManufacture (int)
ProductLine (nchar)
Class (nchar)
Style (nchar)
ProductSubcategoryID (int)
ProductModelID (int)
SellStartDate (datetime)

Filter statement:

```
SELECT <published_columns> FROM [Production].
[Product] WHERE [SafetyStockLevel] < 500
```

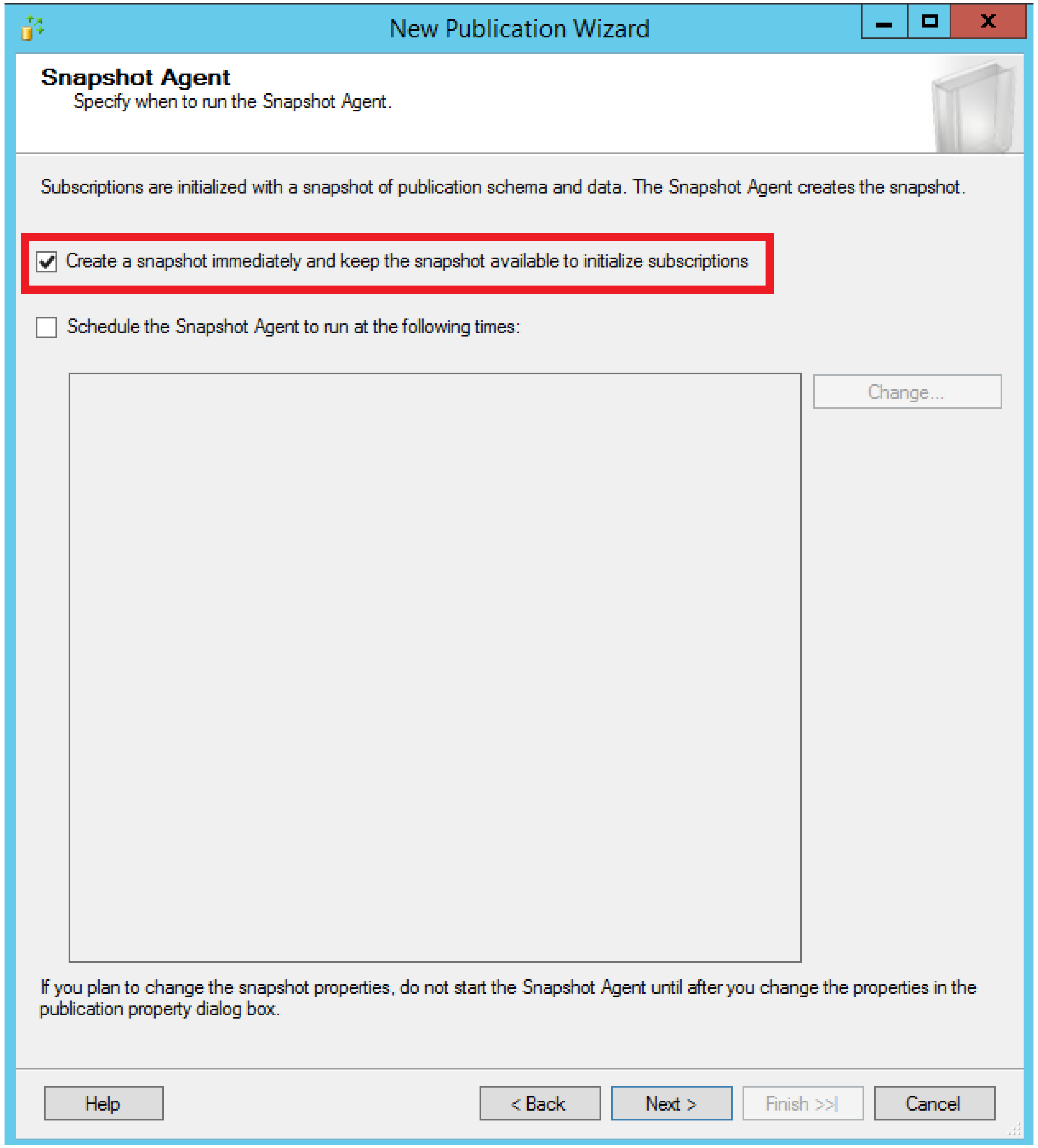
New Publication Wizard

Filter Table Rows
Add filters to exclude unwanted rows from published tables.

Filtered Tables:
Product (Production)

Filter: WHERE [SafetyStockLevel] < 500

9. Select **OK**, and then select **Next**.
10. Select the **Create a snapshot immediately and keep the snapshot available to initialize subscriptions** check box, and select **Next**:



Snapshot Agent

Specify when to run the Snapshot Agent.

Subscriptions are initialized with a snapshot of publication schema and data. The Snapshot Agent creates the snapshot.

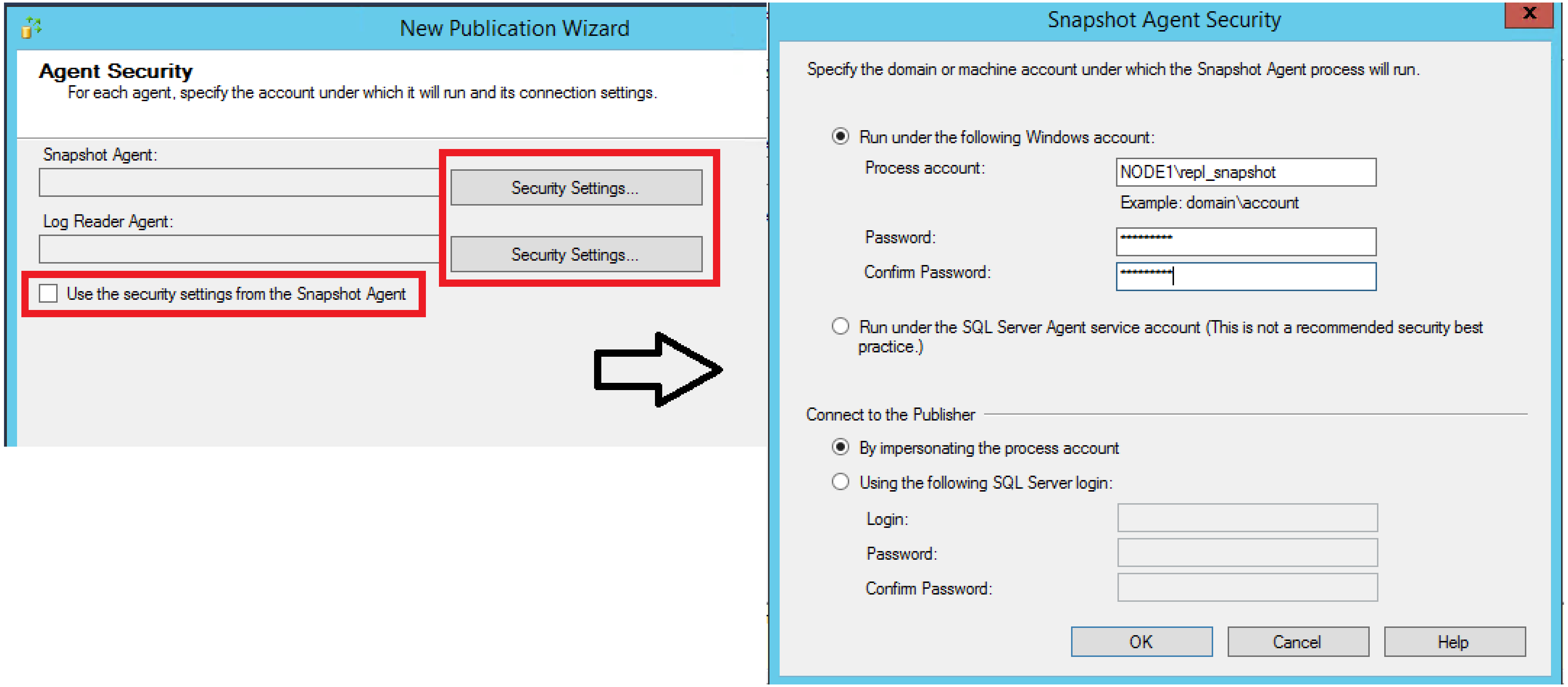
☑ Create a snapshot immediately and keep the snapshot available to initialize subscriptions

□ Schedule the Snapshot Agent to run at the following times:

If you plan to change the snapshot properties, do not start the Snapshot Agent until after you change the properties in the publication property dialog box.

11. On the **Agent Security** page, clear the **Use the security settings from the Snapshot Agent** check box.

    Select **Security Settings** for the Snapshot Agent. Enter <*Publisher_Machine_Name*>**\repl_snapshot** in the **Process account** box, supply the password for this account, and then select **OK**.



New Publication Wizard

Agent Security

For each agent, specify the account under which it will run and its connection settings.

Snapshot Agent:

Log Reader Agent:

□ Use the security settings from the Snapshot Agent

Snapshot Agent Security

Specify the domain or machine account under which the Snapshot Agent process will run.

● Run under the following Windows account:

Process account: NODE1\repl_snapshot

Example: domain\account

Password: **********

Confirm Password: **********

○ Run under the SQL Server Agent service account (This is not a recommended security best practice.)

Connect to the Publisher

● By impersonating the process account

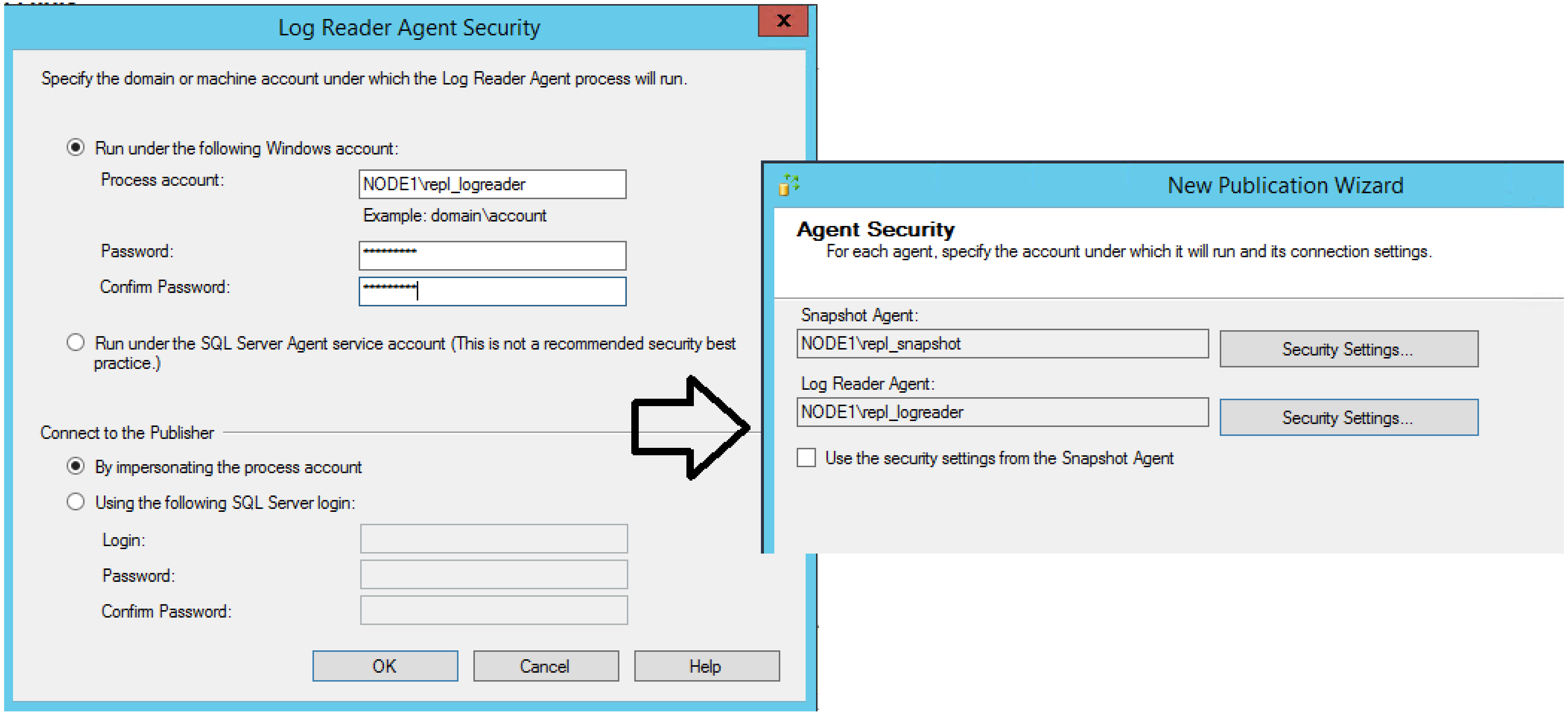
○ Using the following SQL Server login:

Login:

Password:

Confirm Password:

12. Repeat the previous step to set <*Publisher_Machine_Name*>**\repl_logreader** as the process account for the Log Reader Agent. Then select **OK**.



Log Reader Agent Security

Specify the domain or machine account under which the Log Reader Agent process will run.

● Run under the following Windows account:

Process account: NODE1\repl_logreader

Example: domain\account

Password: **********

Confirm Password: **********

○ Run under the SQL Server Agent service account (This is not a recommended security best practice.)

Connect to the Publisher

● By impersonating the process account

○ Using the following SQL Server login:

Login:

Password:

Confirm Password:

New Publication Wizard

Agent Security

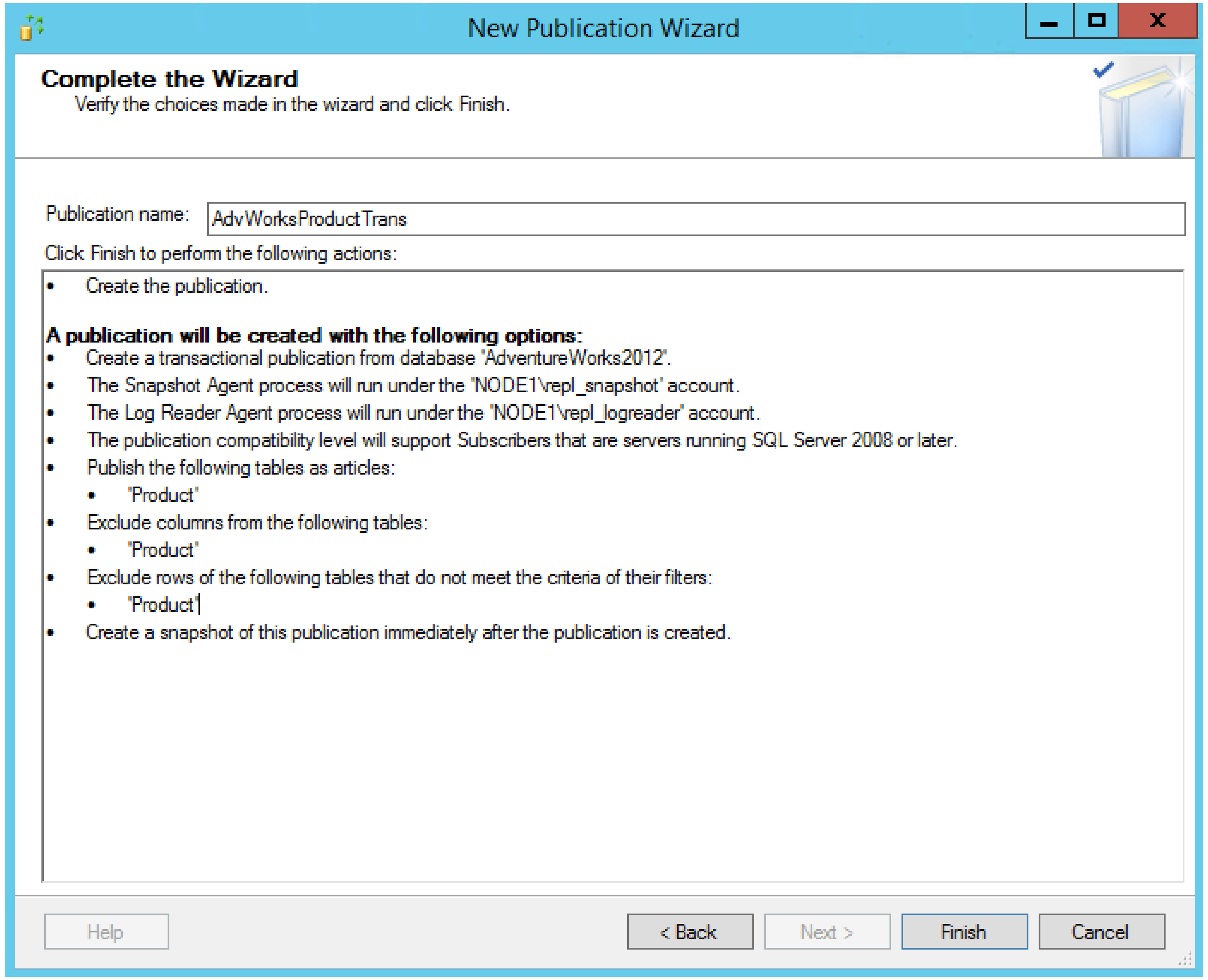
For each agent, specify the account under which it will run and its connection settings.

Snapshot Agent: NODE1\repl_snapshot

Log Reader Agent: NODE1\repl_logreader

□ Use the security settings from the Snapshot Agent

13. On the **Complete the Wizard** page, type **AdvWorksProductTrans** in the **Publication name** box, and select **Finish**:



Complete the Wizard

Verify the choices made in the wizard and click Finish.

Publication name: AdvWorksProductTrans

Click Finish to perform the following actions:

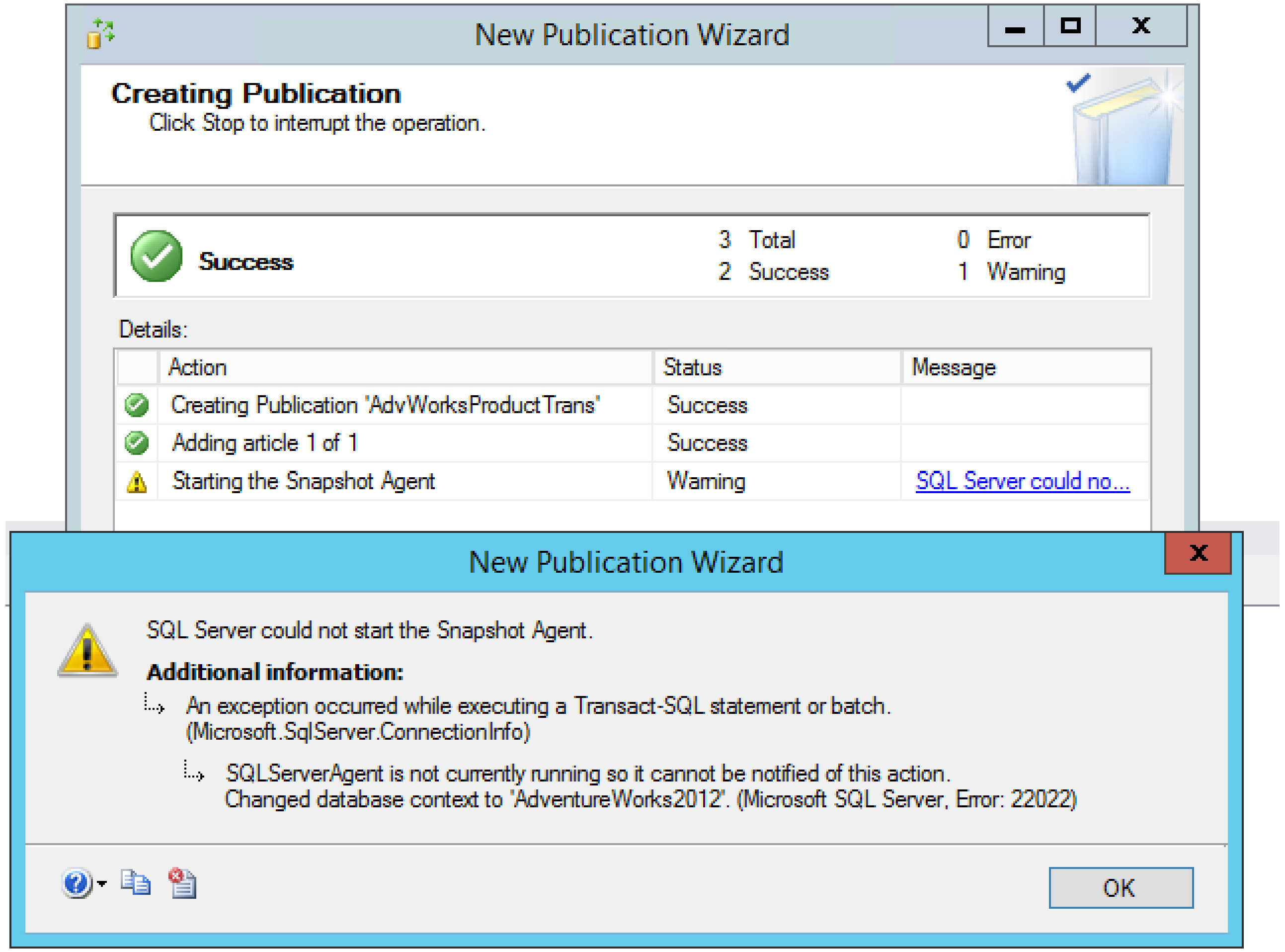
- Create the publication.

A publication will be created with the following options:

- Create a transactional publication from database 'AdventureWorks2012'.
- The Snapshot Agent process will run under the 'NODE1\repl_snapshot' account.
- The Log Reader Agent process will run under the 'NODE1\repl_logreader' account.
- The publication compatibility level will support Subscribers that are servers running SQL Server 2008 or later.
- Publish the following tables as articles:
  - 'Product'
- Exclude columns from the following tables:
  - 'Product'
- Exclude rows of the following tables that do not meet the criteria of their filters:
  - 'Product'
- Create a snapshot of this publication immediately after the publication is created.

14. After the publication is created, select **Close** to complete the wizard.

You might encounter the following error if your SQL Server Agent is not running when you try to create the publication. This error indicates that your publication was created successfully but your Snapshot Agent was unable to start. If this happens, you'll need to start the SQL Server Agent, and then manually start the Snapshot Agent. The next section gives instructions.



Creating Publication

Click Stop to interrupt the operation.

Success

3 Total
2 Success
0 Error
1 Warning

Details:

	Action	Status	Message
✓	Creating Publication 'AdvWorksProductTrans'	Success	
✓	Adding article 1 of 1	Success	
⚠	Starting the Snapshot Agent	Warning	SQL Server could no...

SQL Server could not start the Snapshot Agent.

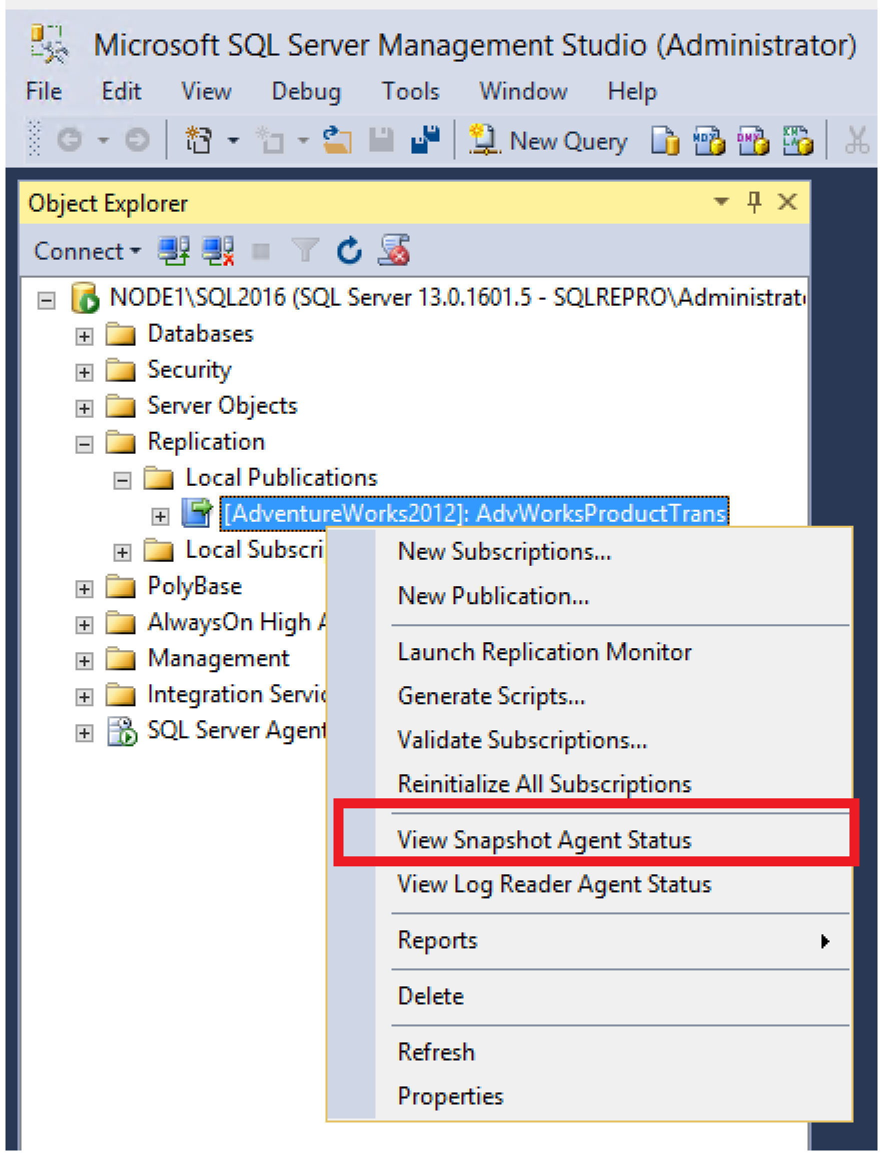
Additional information:

An exception occurred while executing a Transact-SQL statement or batch. (Microsoft.SqlServer.ConnectionInfo)

SQLServerAgent is not currently running so it cannot be notified of this action.
Changed database context to 'AdventureWorks2012'. (Microsoft SQL Server, Error: 22022)

View the status of snapshot generation

1. Connect to the publisher in SQL Server Management Studio, expand the server node, and then expand the **Replication** folder.
2. In the **Local Publications** folder, right-click **AdvWorksProductTrans**, and then select **View Snapshot Agent Status**:


Microsoft SQL Server Management Studio (Administrator)
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Help
New Query
Object Explorer
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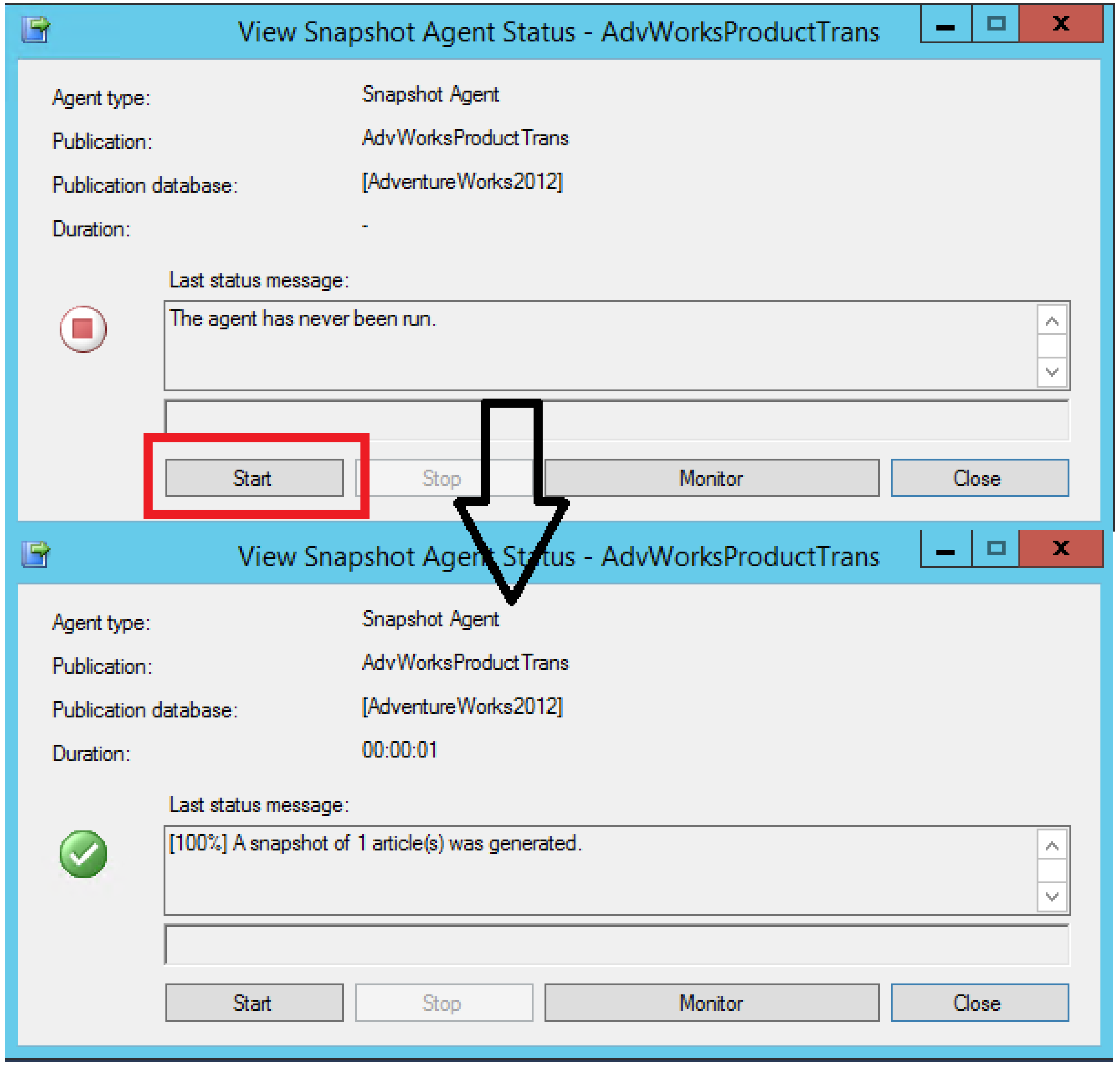
NODE1\SQL2016 (SQL Server 13.0.1601.5 - SQLREPRO\Administrat
Databases
Security
Server Objects
Replication
Local Publications
[AdventureWorks2012]: AdvWorksProductTrans
Local Subscri
PolyBase
AlwaysOn High A
Management
Integration Servic
SQL Server Agent
New Subscriptions...
New Publication...
Launch Replication Monitor
Generate Scripts...
Validate Subscriptions...
Reinitialize All Subscriptions
View Snapshot Agent Status
View Log Reader Agent Status
Reports
Delete
Refresh
Properties

3. The current status of the Snapshot Agent job for the publication appears. Verify that the snapshot job has succeeded before you continue to the next section.

If your SQL Server Agent was not running when you created the publication, you'll see that the Snapshot Agent was never run when you check the Snapshot Agent status for your publication. If that's the case, select **Start** to start your Snapshot Agent:



View Snapshot Agent Status - AdvWorksProductTrans

Agent type: Snapshot Agent

Publication: AdvWorksProductTrans

Publication database: [AdventureWorks2012]

Duration: -

Last status message:

The agent has never been run.

View Snapshot Agent Status - AdvWorksProductTrans

Agent type: Snapshot Agent

Publication: AdvWorksProductTrans

Publication database: [AdventureWorks2012]

Duration: 00:00:01

Last status message:

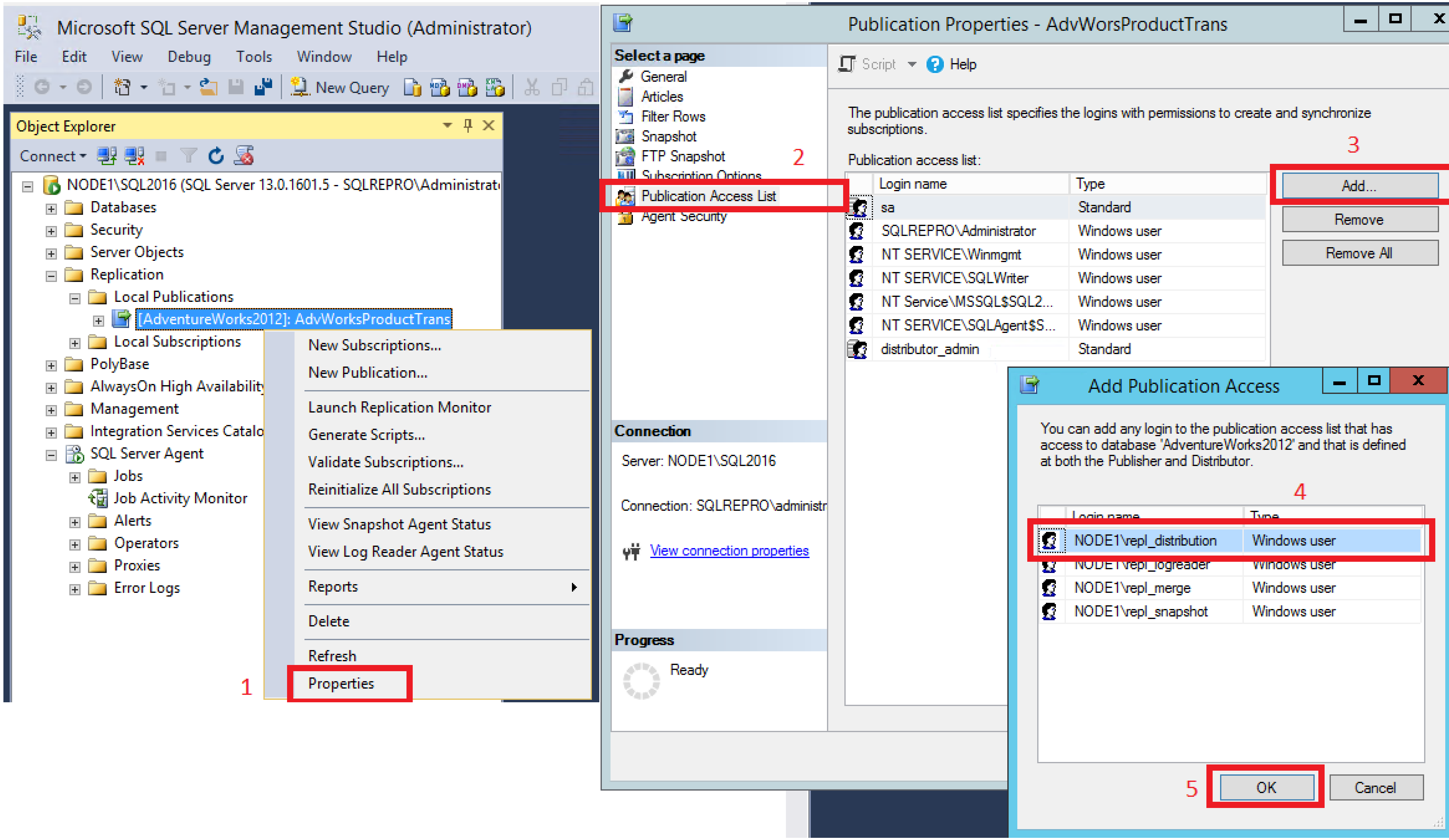
[100%] A snapshot of 1 article(s) was generated.

If you see an error here, see Troubleshooting Snapshot Agent error.

Add the Distribution Agent login to the PAL

1. Connect to the publisher in SQL Server Management Studio, expand the server node, and then expand the **Replication** folder.
2. In the **Local Publications** folder, right-click **AdvWorksProductTrans**, and then select **Properties**. The **Publication Properties** dialog box appears.

   a. Select the **Publication Access List** page, and select **Add**.
   b. In the **Add Publication Access** dialog box, select <*Publisher_Machine_Name*>**\repl_distribution**, and select **OK**.



Server: NODE1\SQL2016

Connection: SQLREPRO\administr

The publication access list specifies the logins with permissions to create and synchronize subscriptions.

Publication access list:

Login name	Type
sa	Standard
SQLREPRO\Administrator	Windows user
NT SERVICE\Winmgmt	Windows user
NT SERVICE\SQLWriter	Windows user
NT Service\MSSQL$SQL2...	Windows user
NT SERVICE\SQLAgent$S...	Windows user
distributor_admin	Standard

You can add any login to the publication access list that has access to database 'AdventureWorks2012' and that is defined at both the Publisher and Distributor.

Login name	Type
NODE1\repl_distribution	Windows user
NODE1\repl_logreader	Windows user
NODE1\repl_merge	Windows user
NODE1\repl_snapshot	Windows user

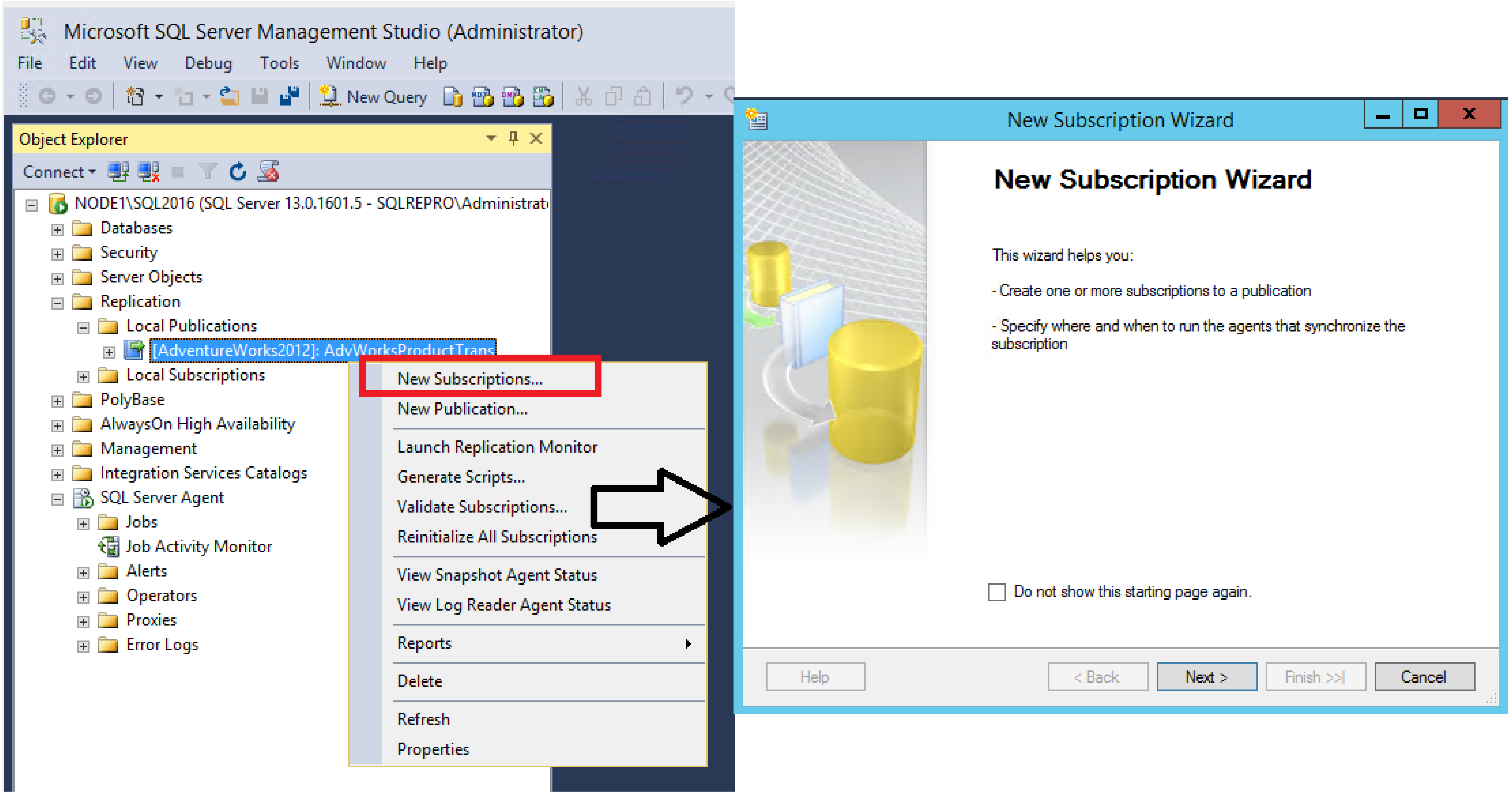
For more information, see Replication programming concepts.

Create a subscription to the transactional publication

In this section, you add a subscriber to the publication that you previously created. This tutorial uses a remote subscriber (NODE2\SQL2016), but you can also add a subscription locally to the publisher.

Create the subscription

1. Connect to the publisher in SQL Server Management Studio, expand the server node, and then expand the **Replication** folder.
2. In the **Local Publications** folder, right-click the **AdvWorksProductTrans** publication, and then select **New Subscriptions**. The New Subscription Wizard starts:



Microsoft SQL Server Management Studio (Administrator)
File Edit View Debug Tools Window Help
New Query
Object Explorer
Connect
NODE1\SQL2016 (SQL Server 13.0.1601.5 - SQLREPRO\Administrat
Databases
Security
Server Objects
Replication
Local Publications
[AdventureWorks2012]: AdvWorksProductTrans
Local Subscriptions
PolyBase
AlwaysOn High Availability
Management
Integration Services Catalogs
SQL Server Agent
Jobs
Job Activity Monitor
Alerts
Operators
Proxies
Error Logs
New Subscriptions...
New Publication...
Launch Replication Monitor
Generate Scripts...
Validate Subscriptions...
Reinitialize All Subscriptions
View Snapshot Agent Status
View Log Reader Agent Status
Reports
Delete
Refresh
Properties
New Subscription Wizard

New Subscription Wizard

This wizard helps you:

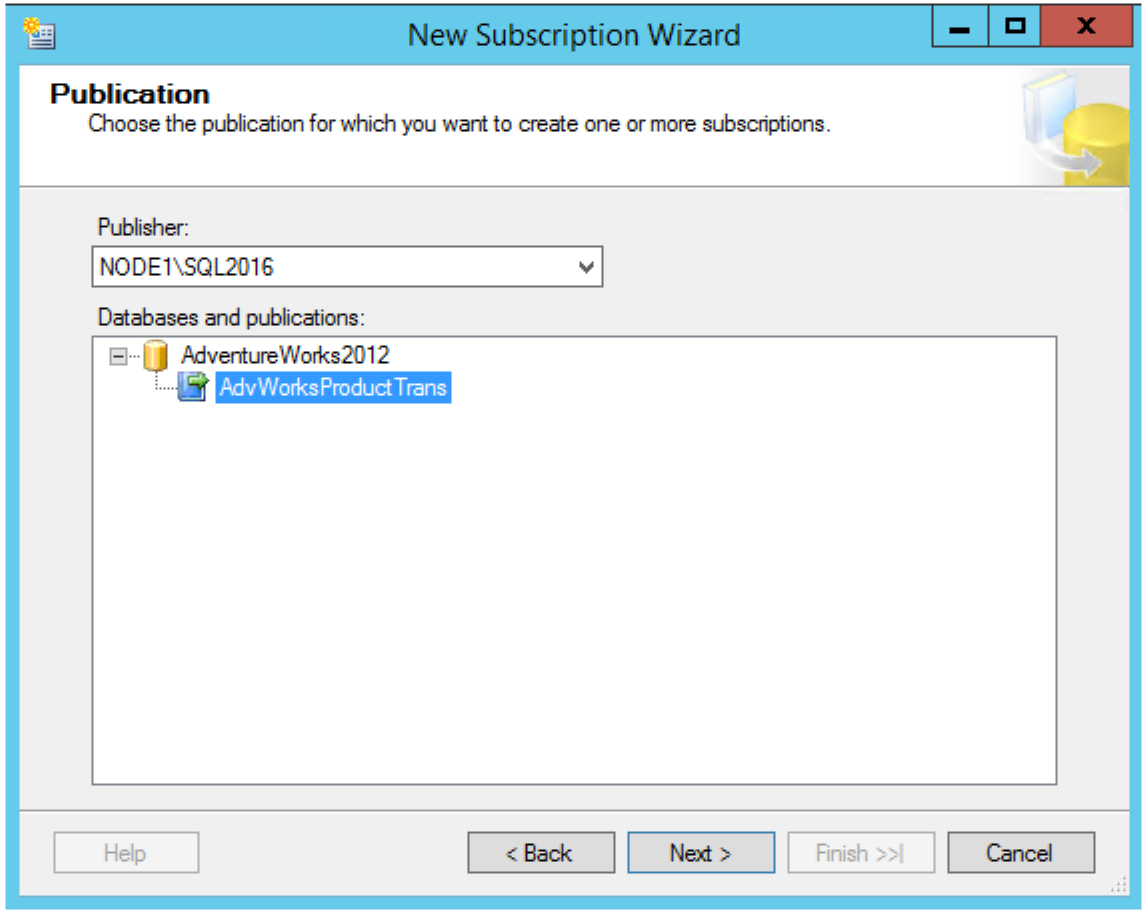
- Create one or more subscriptions to a publication

- Specify where and when to run the agents that synchronize the subscription

□ Do not show this starting page again.

Help
< Back
Next >
Finish >>|
Cancel

3. On the **Publication** page, select **AdvWorksProductTrans**, and then select **Next**:



Publication

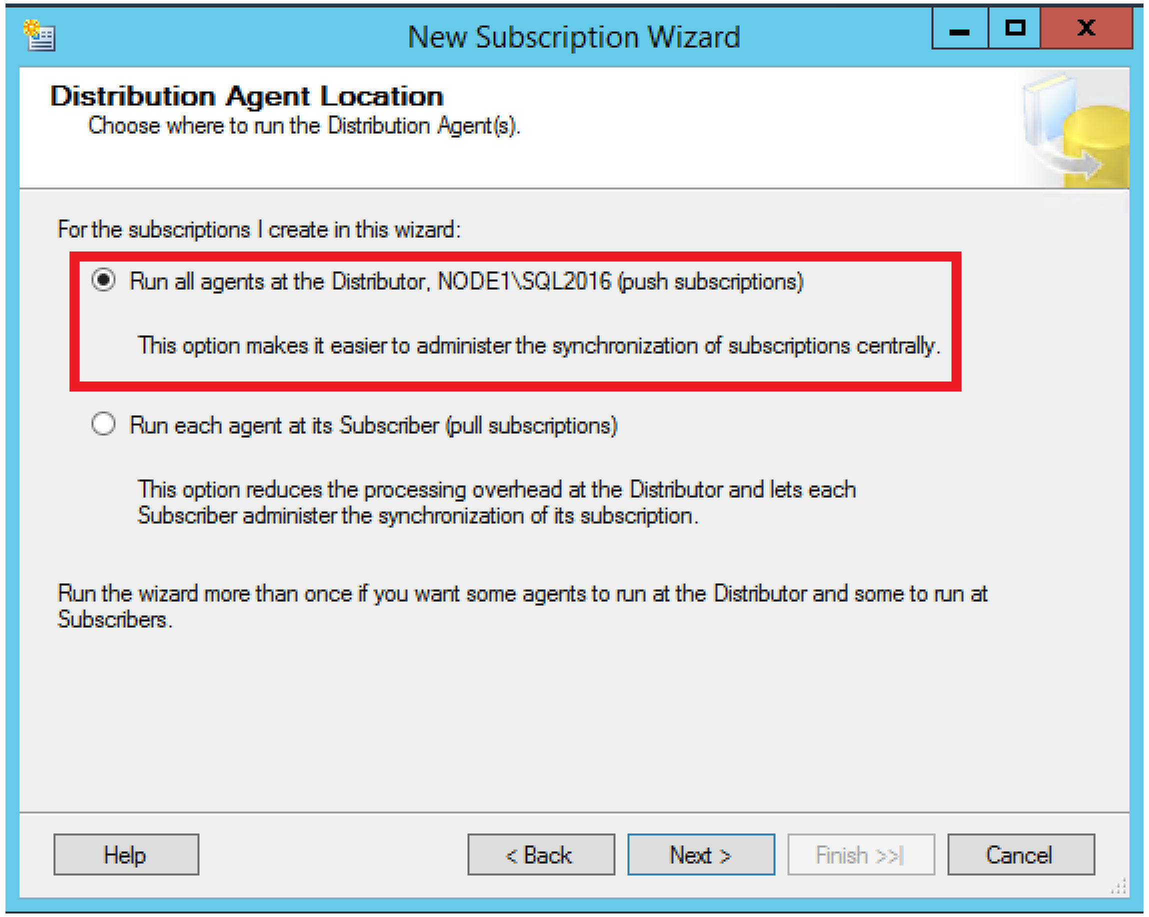
Choose the publication for which you want to create one or more subscriptions.

Publisher: NODE1\SQL2016

Databases and publications:

- AdventureWorks2012
  - AdvWorksProductTrans

4. On the **Distribution Agent Location** page, select **Run all agents at the Distributor**, and then select **Next**. For more information on pull and push subscriptions, see Subscribe to publications.



Distribution Agent Location

Choose where to run the Distribution Agent(s).

For the subscriptions I create in this wizard:

● Run all agents at the Distributor, NODE1\SQL2016 (push subscriptions)

This option makes it easier to administer the synchronization of subscriptions centrally.

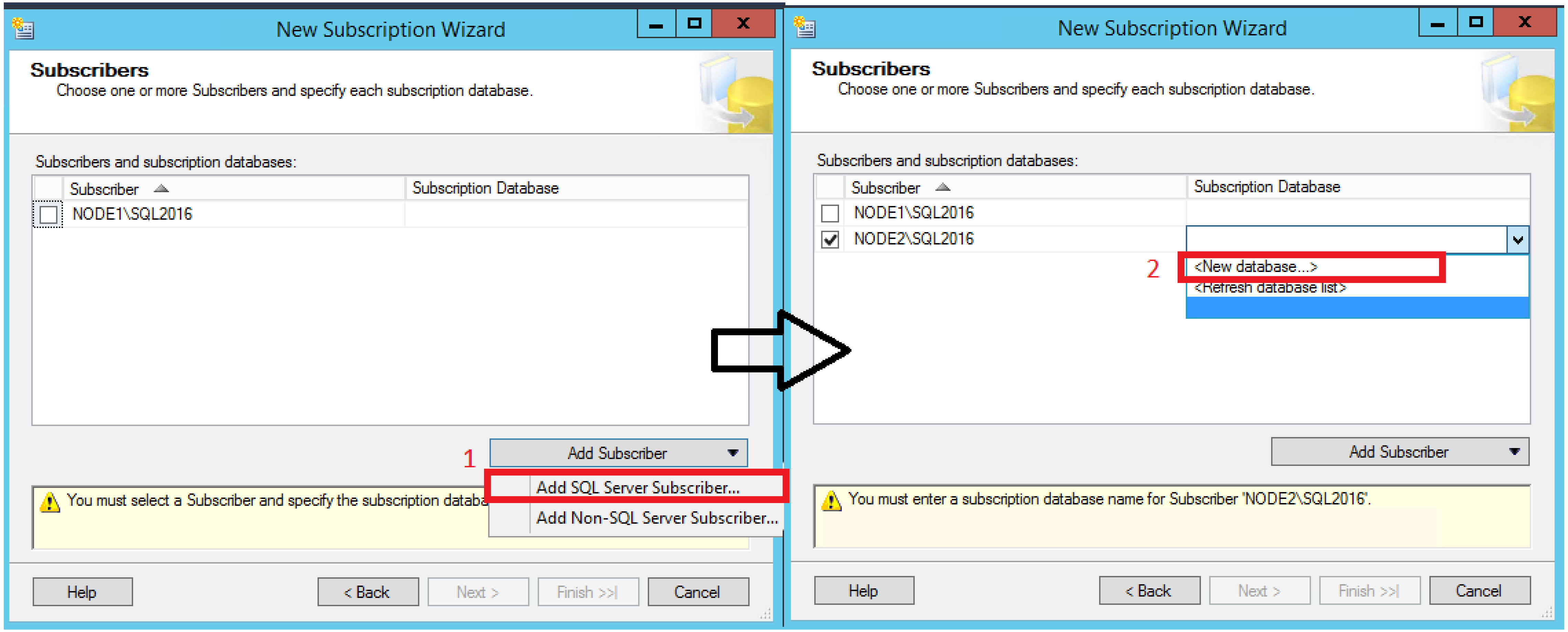
○ Run each agent at its Subscriber (pull subscriptions)

This option reduces the processing overhead at the Distributor and lets each Subscriber administer the synchronization of its subscription.

Run the wizard more than once if you want some agents to run at the Distributor and some to run at Subscribers.

5. On the **Subscribers** page, if the name of the subscriber instance is not displayed, select **Add Subscriber**, and then select **Add SQL Server Subscriber** from the drop-down list. This step opens the **Connect to Server** dialog box. Enter the subscriber instance name and then select **Connect**.

   After the subscriber has been added, select the check box next to the instance name of your subscriber. Then select **New Database** under **Subscription Database**.



New Subscription Wizard

Subscribers

Choose one or more Subscribers and specify each subscription database.

Subscribers and subscription databases:

	Subscriber	Subscription Database
□	NODE1\SQL2016	

You must select a Subscriber and specify the subscription databa

New Subscription Wizard

Subscribers

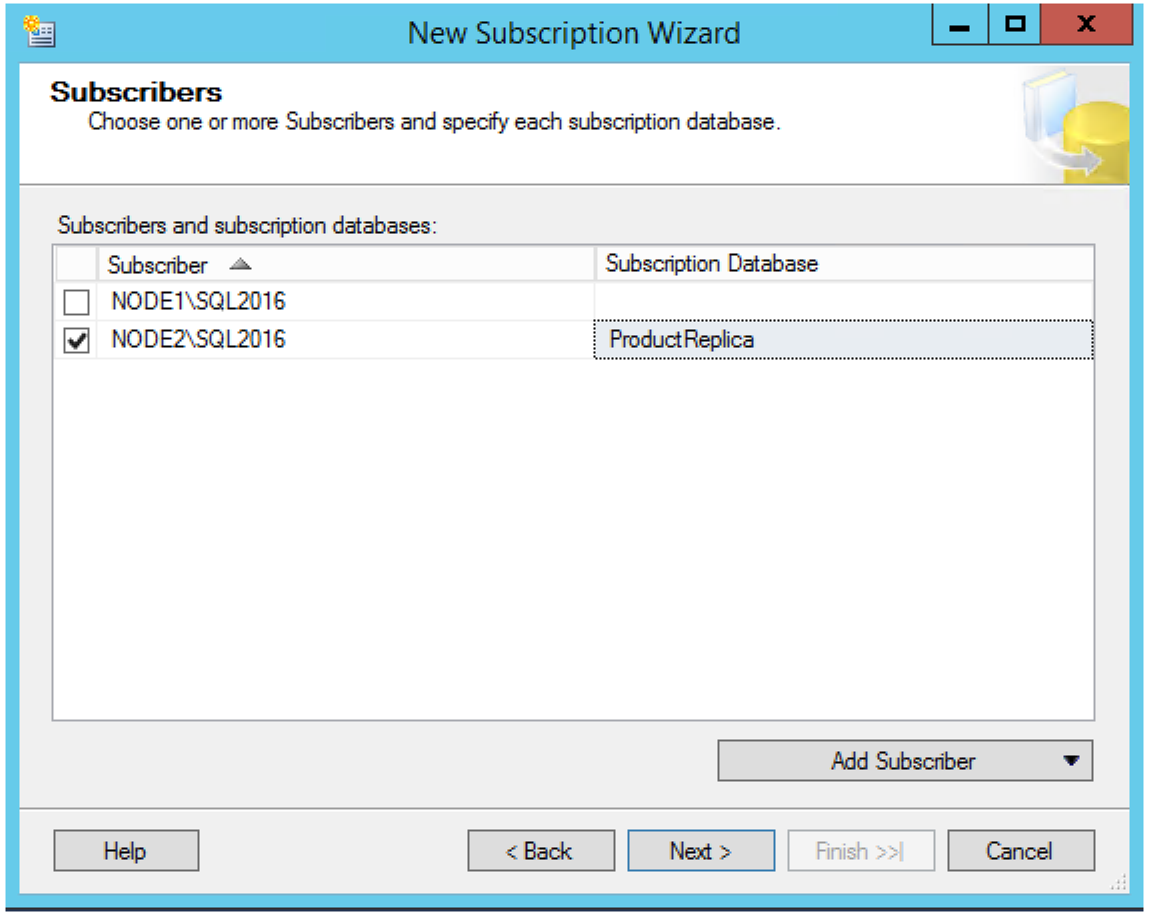
Choose one or more Subscribers and specify each subscription database.

Subscribers and subscription databases:

	Subscriber	Subscription Database
□	NODE1\SQL2016	
☑	NODE2\SQL2016	

You must enter a subscription database name for Subscriber 'NODE2\SQL2016'.

6. The **New Database** dialog box appears. Enter **ProductReplica** in the **Database name** box, select **OK**, and then select **Next**:



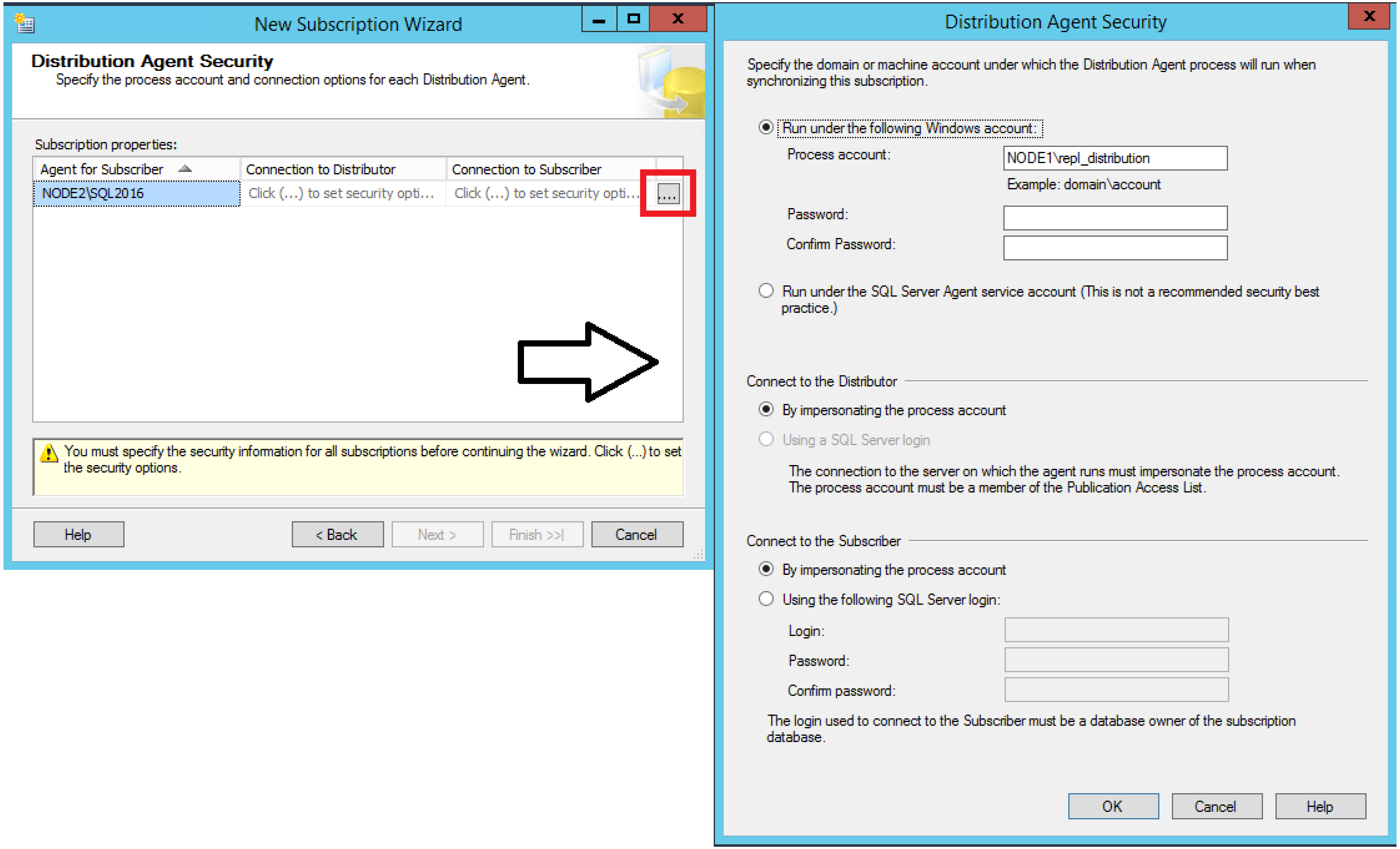
Subscribers

Choose one or more Subscribers and specify each subscription database.

Subscribers and subscription databases:

	Subscriber	Subscription Database
□	NODE1\SQL2016	
☑	NODE2\SQL2016	ProductReplica

7. On the **Distribution Agent Security** page, select the ellipsis (**...**) button. Enter <*Publisher_Machine_Name*>**\repl_distribution** in the **Process account** box, enter the password for this account, select **OK**, and then select **Next**.



New Subscription Wizard

Distribution Agent Security

Specify the process account and connection options for each Distribution Agent.

Subscription properties:

Agent for Subscriber	Connection to Distributor	Connection to Subscriber	
NODE2\SQL2016	Click (...) to set security opti...	Click (...) to set security opti...	...

You must specify the security information for all subscriptions before continuing the wizard. Click (...) to set the security options.

Distribution Agent Security

Specify the domain or machine account under which the Distribution Agent process will run when synchronizing this subscription.

● Run under the following Windows account:

Process account: NODE1\repl_distribution

Example: domain\account

Password:

Confirm Password:

○ Run under the SQL Server Agent service account (This is not a recommended security best practice.)

Connect to the Distributor

● By impersonating the process account

○ Using a SQL Server login

The connection to the server on which the agent runs must impersonate the process account. The process account must be a member of the Publication Access List.

Connect to the Subscriber

● By impersonating the process account

○ Using the following SQL Server login:

Login:

Password:

Confirm password:

The login used to connect to the Subscriber must be a database owner of the subscription database.

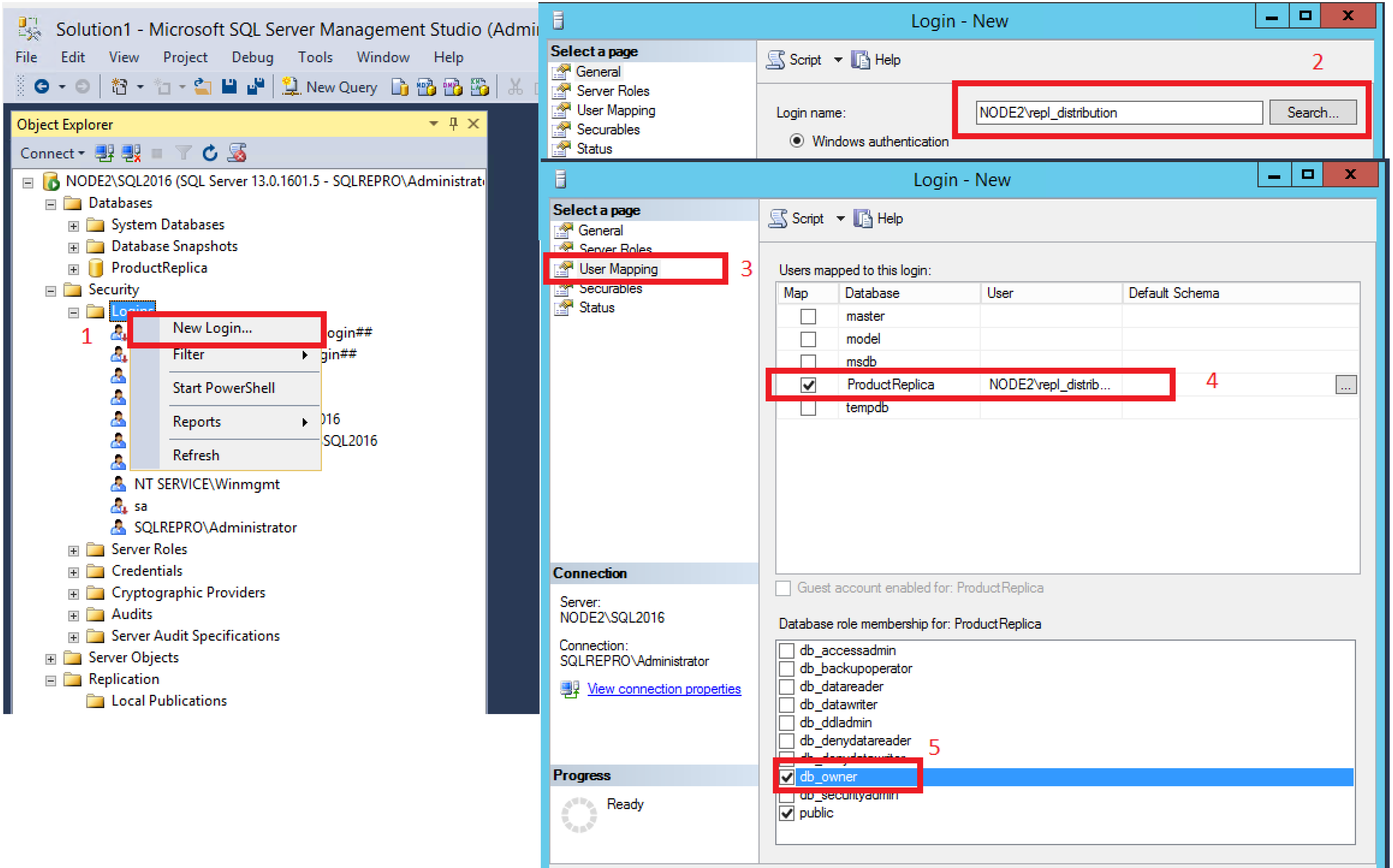
8. Select **Finish** to accept the default values on the remaining pages and complete the wizard.

Set database permissions at the subscriber

1. Connect to the subscriber in SQL Server Management Studio. Expand **Security**, right-click **Logins**, and then select **New Login**.

   a. On the **General** page, under **Login Name**, select **Search** and add the login for <*Subscriber_Machine_Name*>**\repl_distribution**.

   b. On the **User Mappings** page, grant the login **db_owner** membership for the **ProductReplica** database.



Login name: NODE2\repl_distribution

● Windows authentication

Users mapped to this login:

Map	Database	User	Default Schema
□	master		
□	model		
□	msdb		
☑	ProductReplica	NODE2\repl_distrib...	
□	tempdb		

□ Guest account enabled for: ProductReplica

Database role membership for: ProductReplica

- □ db_accessadmin
- □ db_backupoperator
- □ db_datareader
- □ db_datawriter
- □ db_ddladmin
- □ db_denydatareader
- □ db_denydatawriter
- ☑ db_owner
- □ db_securityadmin
- ☑ public

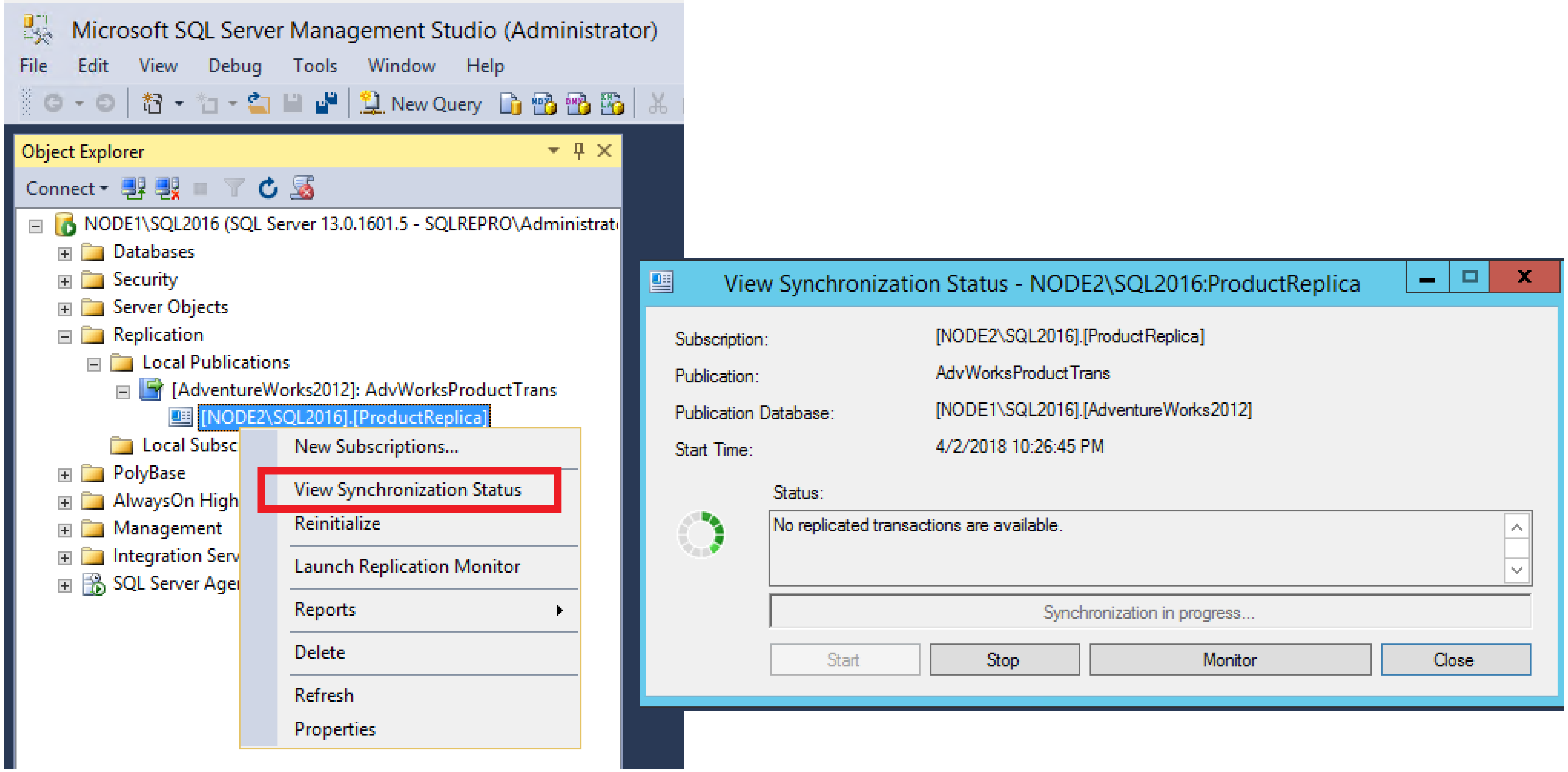
Server:
NODE2\SQL2016

Connection:
SQLREPRO\Administrator

2. Select **OK** to close the **New Login** dialog box.

View the synchronization status of the subscription

1. Connect to the publisher in SQL Server Management Studio. Expand the server node, and then expand the **Replication** folder.
2. In the **Local Publications** folder, expand the **AdvWorksProductTrans** publication, right-click the subscription in the **ProductReplica** database, and then select **View Synchronization Status**. The current synchronization status of the subscription appears:


Microsoft SQL Server Management Studio (Administrator)
File
Edit
View
Debug
Tools
Window
Help
New Query
Object Explorer
Connect
NODE1\SQL2016 (SQL Server 13.0.1601.5 - SQLREPRO\Administrat
Databases
Security
Server Objects
Replication
Local Publications
[AdventureWorks2012]: AdvWorksProductTrans
[NODE2\SQL2016].[ProductReplica]
Local Subsc
PolyBase
AlwaysOn High
Management
Integration Serv
SQL Server Agen
New Subscriptions...
View Synchronization Status
Reinitialize
Launch Replication Monitor
Reports
Delete
Refresh
Properties
View Synchronization Status - NODE2\SQL2016:ProductReplica
Start
Stop
Monitor
Close

Subscription: [NODE2\SQL2016].[ProductReplica]

Publication: AdvWorksProductTrans

Publication Database: [NODE1\SQL2016].[AdventureWorks2012]

Start Time: 4/2/2018 10:26:45 PM

Status: No replicated transactions are available.

Synchronization in progress...

3. If the subscription is not visible under **AdvWorksProductTrans**, select the F5 key to refresh the list.

For more information, see:

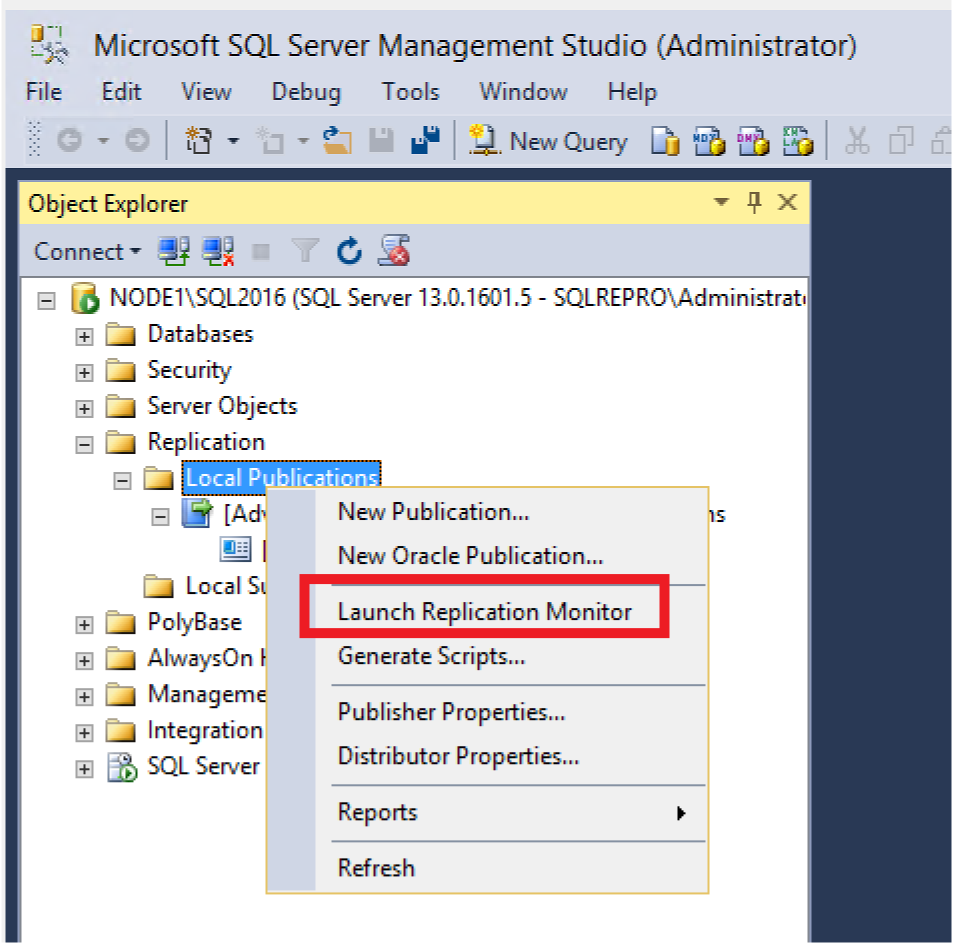
- Initialize a subscription with a snapshot

- Create a push subscription
- Subscribe to publications

Measure replication latency

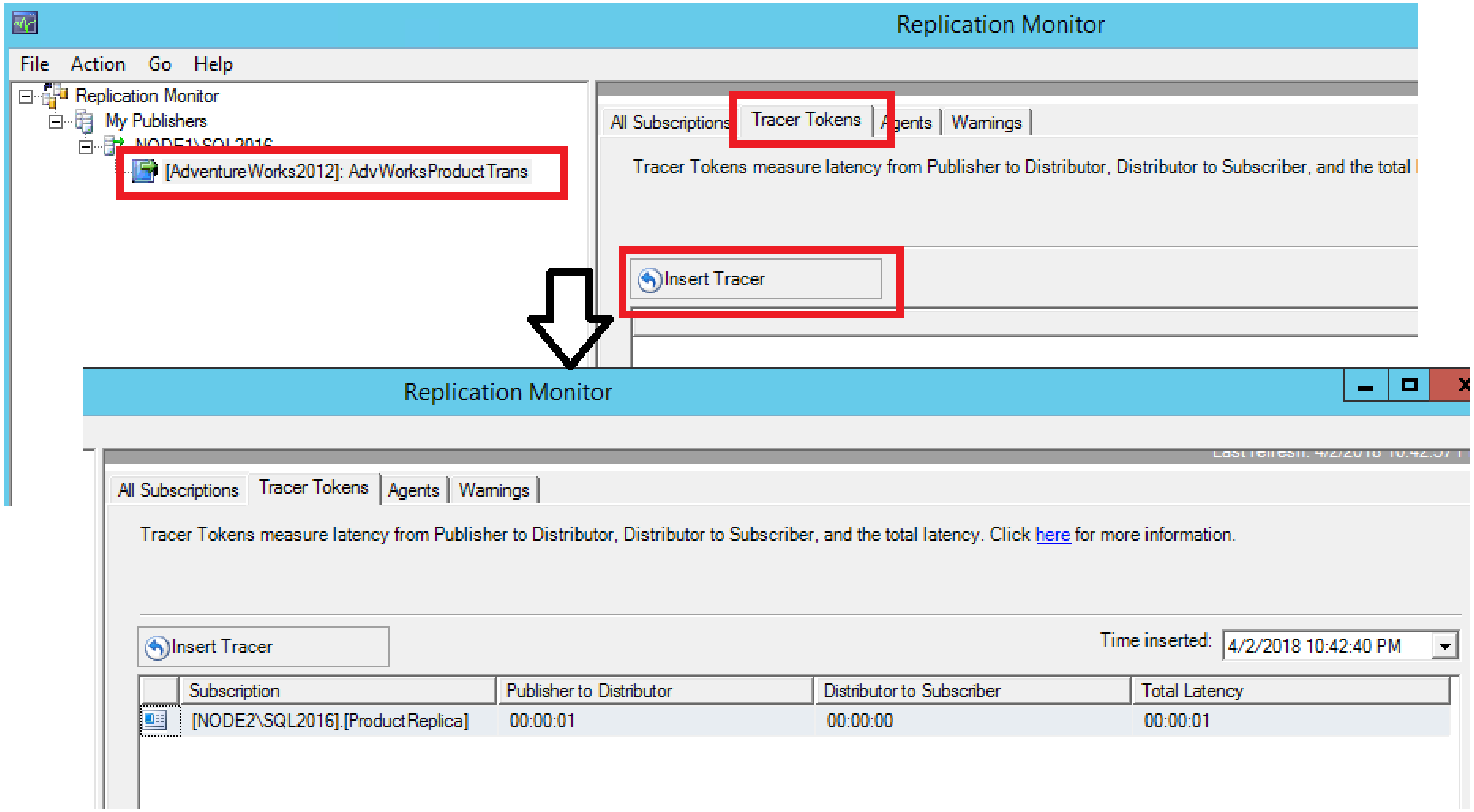
In this section, you use tracer tokens to verify that changes are being replicated to the subscriber and to determine latency. Latency is the time it takes for a change made at the publisher to appear to the subscriber.

1. Connect to the publisher in SQL Server Management Studio. Expand the server node, right-click the **Replication** folder, and then select **Launch Replication Monitor**:



2. Expand a publisher group in the left pane, expand the publisher instance, and then select the **AdvWorksProductTrans** publication.

   a. Select the **Tracer Tokens** tab.
   b. Select **Insert Tracer**.
   c. View elapsed time for the tracer token in the following columns: **Publisher to Distributor**, **Distributor to Subscriber**, **Total Latency**. A value of **Pending** indicates that the token has not reached a specified point.



Tracer Tokens measure latency from Publisher to Distributor, Distributor to Subscriber, and the total

Tracer Tokens measure latency from Publisher to Distributor, Distributor to Subscriber, and the total latency. Click here for more information.

Time inserted: 4/2/2018 10:42:40 PM

Subscription	Publisher to Distributor	Distributor to Subscriber	Total Latency
[NODE2\SQL2016].[ProductReplica]	00:00:01	00:00:00	00:00:01

For more information, see:

- [Measure latency and validate connections for transactional replication]
- [Finding errors with the transactional replication agents]

Next steps

You have successfully configured both your publisher and your subscriber for transactional replication. You can now insert, update, or delete data in the **Product** table at the publisher. Then you can query the **Product** table at the subscriber to view the replicated changes.

The next article will teach you how to configure merge replication:

Tutorial: Configure replication between a server and mobile clients (merge)