

Network Automation: Start Putting Your Cisco Network to Work

Stressed? No time? Buried in reactive manual tasks? Your network design almost working?

Learn how network automation allows you to automate manual tasks, better operate existing network services, and even enable new and innovative networking solutions.

Your Cisco IOS® Software network provides a wealth of embedded automation capabilities and advanced Device Manageability Instrumentation (DMI) and Embedded Automation Systems (EASy) to design and implement your own automations within the network.

Read on and find out how you can start using these capabilities today in just a few simple steps—and gain some time back from your work day, solve one of those pending action items, and even make the seemingly impossible happen.

This paper offers an introduction to the concept and reality of network automation, followed by three steps you can take to easily and quickly adopt network automation and have some immediate results.

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The Challenge

Your Cisco IOS Software-based network is configurable—it has always been; that's nothing new. However, your network is no longer what it used to be. In the past, network services were offered on a best-effort basis in rather static environments. Today network services are operated in a dynamic business environment, based on layered and virtualized architectures, and within tight budgetary and regulatory boundaries.

Do you end up having to do repetitive tasks manually? Is there a pile of unanswered questions and unfulfilled requirements? Are your business requirements just a bit off the beaten path? Then you are in good company. With IP networks making their way into every aspect of our work and lives and businesses, a very diverse range of networking architectures require tailored solutions to some questions.

The good news is that over the last decade the instrumentation inside your Cisco IOS Software-based network has been greatly increased. There are no longer just configurable standard features, but your network today includes a diverse toolset to implement advanced reactive and proactive scenarios and even to program your own custom behavior into the network. See Figure 1.

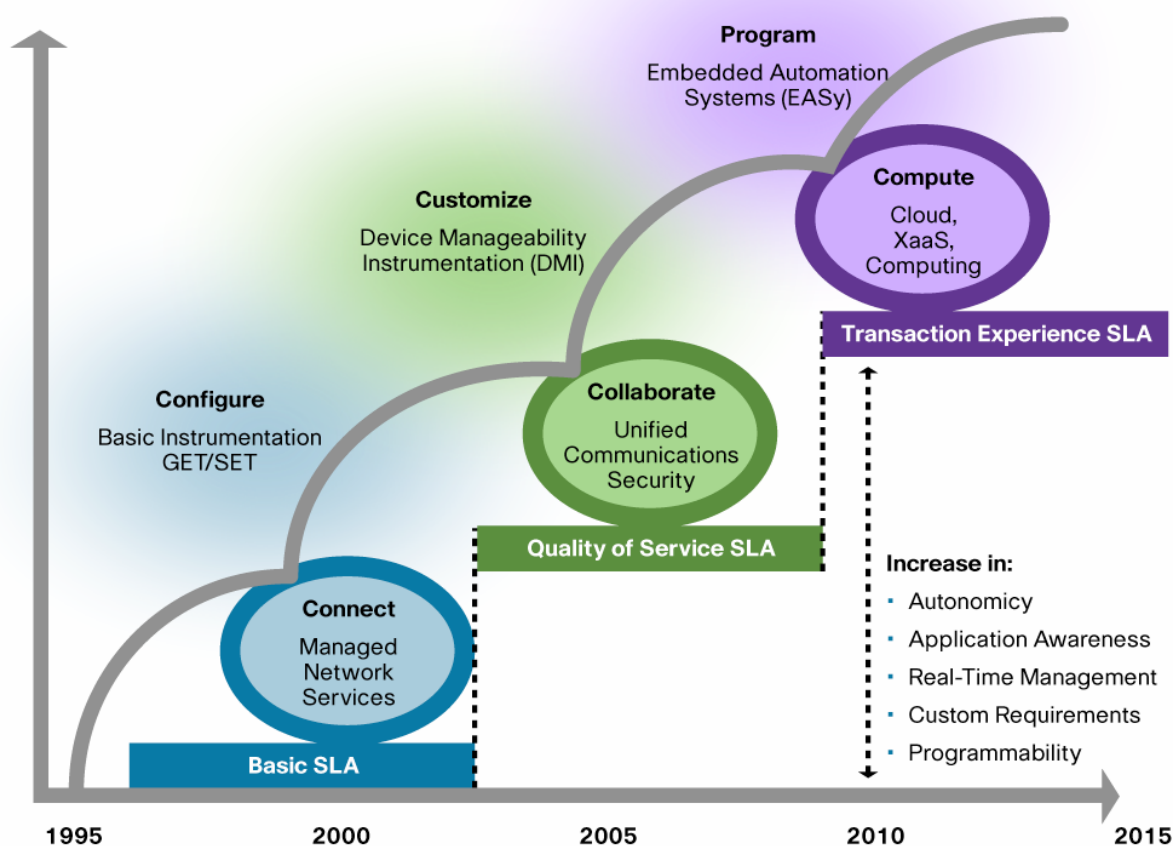
Figure 1. Device Manageability Instrumentation Typically Available in a Cisco IOS Network Today

Fault	Configuration	Performance	Accounting
<ul style="list-style-type: none"> ▪ IP OAM: Ping, Trace, BFD, ISG per session ▪ 802.3ah: Link monitoring and remote fault indication ▪ 802.1ag: Continuity check, L2 ping, trace, AIS ▪ MPLS OAM: LSP ping, LSP trace, VCCV ▪ EEM: Embedded Event Manager ▪ EVENT-MIB: OID-based triggers, events, or SNMP Set, IETF DISMON ▪ EXPRESSION-MIB: OID expression-based triggers, IETF DISMON ▪ ... 	<ul style="list-style-type: none"> ▪ Config CLI: Diff, logging, lock, replace, rollback ▪ E-LMI: Parameter and status signaling ▪ E-DI: Enhanced Device Interface, CLI, Perl, IETF Netconf ▪ EMM: Embedded Menu Manager ▪ NETCONF: IETF NETCONF XML PI ▪ CNS and WSMA ▪ TR-069 ▪ KRON: Command scheduler ▪ AutoInstall: Bootstrapping ▪ IOS.sh: IOS Shell ▪ SmartInstall ▪ Auto SmartPorts ▪ ... 	<ul style="list-style-type: none"> ▪ Auto IP SLA: Delay, jitter, loss probability ▪ CBQoS MIB: Class-based QoS ▪ NBAR ▪ RMON ▪ EPC: Embedded Packet Capture ▪ ERM: Embedded Resource Manager ▪ GOLD: Generic Online Diagnosis ▪ Smart Call Home: Preventive maintenance ▪ VidMon: Video Monitoring ▪ ... 	<ul style="list-style-type: none"> ▪ Flexible NetFlow: IETF IPFIX ▪ BGP Policy Accounting: Includes AS information ▪ Periodic MIB Bulk Data Collection and Transfer ▪ ...
			Security
			<ul style="list-style-type: none"> ▪ Auto Secure: One-touch device hardening ▪ LDP Auth: Message authentication ▪ Routing Auth: MD5 authentication, BGP, OSPF ▪ ...

Network Automation

Network automation uses DMI and EASy to design and implement your own automations within the network—the way you need them to satisfy your requirements.

You can start automating some of those manual, reactive tasks and tailor the network to optimally satisfy your business needs. Use the smart embedded automation systems capabilities, and operating a network can be effective, efficient, and fun again. See Figure 2.

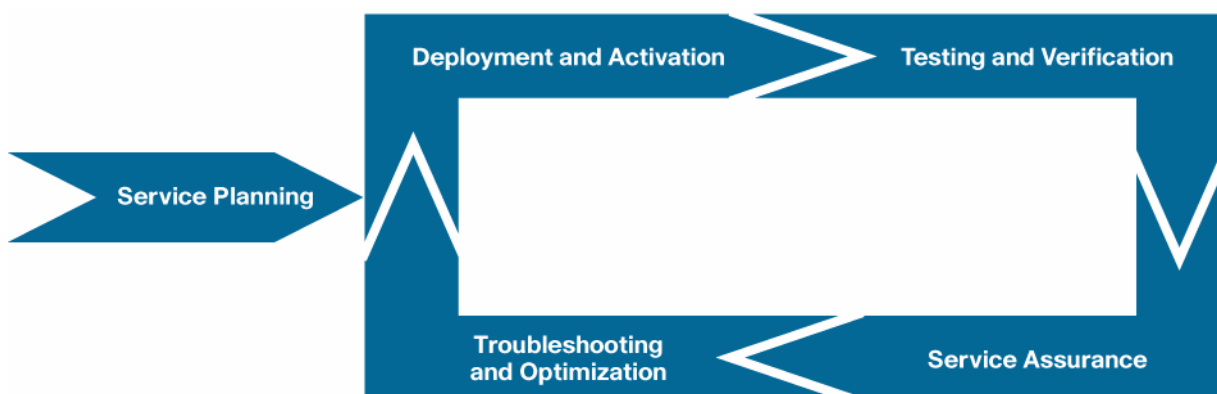
Figure 2. Evolution Toward Network Automation

Getting started is easy—just take it step by step.

Step 1: Automate a Manual Task

First let's automate a small manual task, which is a typical initial step when adopting network automation. In addition to increasing efficiency and quality, this will also give you back some time, so you can further explore and benefit from network automation.

How do you find a suitable small manual task? Just think through the various activities required to drive a network service along its life cycle—from early design and engineering, through rollout, testing, verification, ongoing monitoring, troubleshooting, and optimization. See Figure 3.

Figure 3. Main Elements and Traditional Scope of Lifecycle Models

To start with, a suitable task should have:

- A clearly defined starting point or trigger
- A desired outcome (what problem are you trying to solve?)
- A well-understood procedure
- All required input locally available on the router or switch (initially)
- All actions and output to take effect locally on the router or switch (initially)

Some typical examples for such a task and its automation include:

- **Planning:** Use Embedded Event Manager (EEM) and Flexible NetFlow (FNF) to periodically export planning-relevant traffic data.
- **Deployment and activation:** Use EEM and the Cisco IOS Software shell (IOS.sh) to automatically apply switch port configurations, depending on the connecting device type and the time of the day—beyond the configurability offered by Smartports or Auto Smartports features.
- **Assurance:** Use IP service-level agreement (SLA) and EEM to adjust topology based on availability, latency, and drop probability of multiple alternative links—beyond the configurability offered by Performance Routing (PfR) features.
- **Troubleshooting and optimization:** Use Tcl scripting and Embedded Menu Manager (EMM) to provide a menu-guided first first-response interface to local IT staff upon branch office network troubleshooting.

You will find further examples in the scripting community on Cisco Beyond or on the EASy website on Cisco.com.

Step 2: Answer an Open Question

In a second step, let's use network automation not only to automate a manual task but to implement a task that was not doable manually. Often such situations arise when a task would normally require:

- Extensive network data export and postprocessing
- Real-time operator intervention at odd or unpredictable times
- Tasks triggered by network events (or a combination thereof)
- Correlation of life network data

Some typical examples for such a task and its automation include:

- **Planning:** Use Event- and Expression-MIB, Embedded Event Manager, and Embedded Resource Manager (ERM) to correlate planning-relevant router resource consumption information.
- **Deployment and activation:** Create a replicable package from an embedded automation, suitable for menu-guided installation on multiple platforms using Tcl scripting and EEM (EASy Installer).
- **Assurance:** Proactively monitor the accuracy on a Network-Based Application Recognition (NBAR) deployment using a combination of Expression-MIB and EEM.
- **Troubleshooting and optimization:** Use FNF, EEM, and Embedded Packet Capture (EPC) to automatically capture low-TTL packets from an unexpected low-TTL sender.

You will find further examples in the scripting community on Cisco Beyond or on the EASy website on Cisco.com.

Step 3: Tailor Your Network to Your Business

And finally in a third step, let's use the power of network automation not only on the existing network—but use the added flexibility and customizability to tailor your next network design to the specific needs of your business.

Have you been in those situations where the standard features did almost what you needed? Was your network design satisfying nearly all requirements? Network automation and your experience from step 1 and step 2 may provide you with additional alternatives to designing your networks.

Some examples for custom architectures enabled by network automation include:

- High availability for autonomous branch offices and remote office containers that are connecting through one of multiple possible mobile access technologies
- Geographically redundant, high-throughput perimeter security clusters automated beyond the configurability of Hot Standby Router Protocol (HSRP) and firewall stateful failover
- Automated self-configuration of newly deployed data center racks using Link Layer Discovery Protocol (LLDP), EEM, the Cisco IOS Software shell and Auto Smartports

You may find further examples in the scripting community on Cisco Beyond or on the EASy website on Cisco.com. However this type of network automation is most beneficial when tailored to your specific needs.

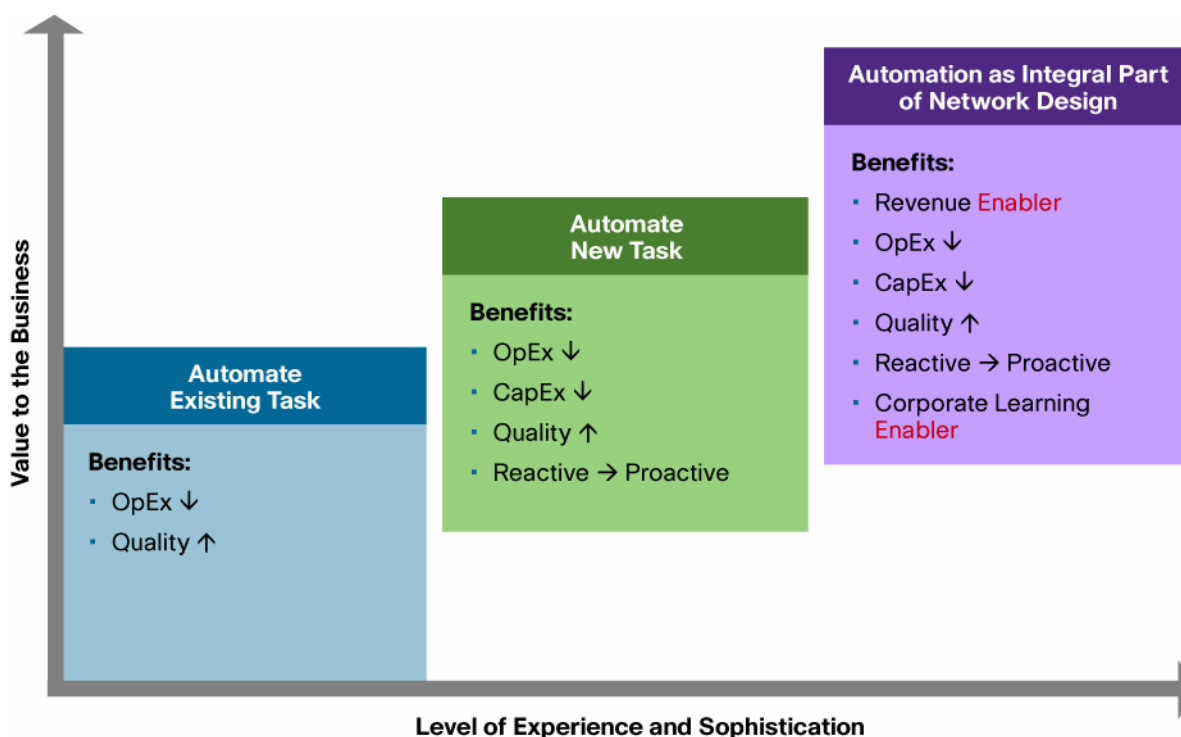
Conclusion

Network Automation has become available based on your Cisco IOS Software network's advanced DMI and EASy.

Network automation is a powerful and flexible enabler to:

- Efficiently automate repetitive manual operational tasks
- Answer open questions and resolve nonfeasible tasks
- Enable tailored solutions and architectures beyond standard features

See Figure 4.

Figure 4. Taxonomy of Network Automation Types

Through a step-by-step approach and thanks to many open source examples made available, network automation is easy to adopt in your network today.

For More Information

A range of Cisco® solutions, products, and services are available for you to implement network automation. For network automation in general, these websites are good starting points to learn and explore:

- Embedded automation systems: <http://www.cisco.com/go/easy>
- Scripting community: <http://www.cisco.com/go/ciscobeyond>
- Management instrumentation: <http://www.cisco.com/go/instrumentation>

There is also a discussion forum to share ideas and discuss questions as well as the ask-easy@cisco.com alias to engage with the team. Your local Cisco contact will be happy to help you reap the benefits provided by network automation.

Network Automation References

Cisco IOS Software

- Embedded automation systems: <http://www.cisco.com/go/easy>
- Scripting community: <http://www.cisco.com/go/ciscobeyond>
- Management instrumentation: <http://www.cisco.com/go/instrumentation>
- Autoinstall: https://www.cisco.com/en/US/docs/ios/fundamentals/configuration/guide/cf_autoinstall.html
- Auto Smartports: http://www.cisco.com/en/US/docs/switches/lan/auto_smartports/12.2_55_se/configuration/guide/asp_cg.html
- Configuration Agent: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cns_services.html

- Embedded Event Manager (EEM): www.cisco.com/go/eem
- Embedded Menu Manager (EMM): http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_emm.html
- Embedded Packet Capture (EPC): <http://www.cisco.com/go/epc>
- Embedded Resource Manager (ERM): http://www.cisco.com/en/US/docs/ios/12_3t/12_3t14/feature/guide/gt_rmimg.html
- Event MIB (RFC 2981): http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cfg_snmp_sup.html
- Expression MIB (RFC 2982): http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cfg_snmp_sup.html
- Flexible Packet Matching (FPM): <http://www.cisco.com/go/fpm>
- Generic Online Diagnostics (GOLD): http://www.cisco.com/en/US/docs/ios/cable/configuration/guide/GOLD_for_Cisco_uBR_10012_Router.html
- ImageAgent: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_cns_services.html
- IP Service-Level Agreements (IP SLA): <http://www.cisco.com/go/ipsla>
- Network-Based Application Recognition (NBAR): <http://www.cisco.com/go/nbar>
- NETCONF and XML PI: http://www.cisco.com/en/US/docs/ios/netmgmt/configuration/guide/nm_xmlpi_v1.html
- NetFlow and Flexible NetFlow (FNF): <http://www.cisco.com/go/fnf>
- Smart Call Home (SCH): <http://www.cisco.com/go/smartcall>
- SmartInstall: http://www.cisco.com/en/US/docs/switches/lan/smart_install/release_12.2_55_se/configuration/guide/smart_install3.html
- Web Services Management Agents (WSMA): <http://www.cisco.com/go/wsma>
- A self-paced hands-on training lab is available through Partner Education Central (EASy DMI Lab and Network Automation Lab): <http://www.cisco.com/go/pec>

Cisco Management and Operation Applications

- Network Management Software: <http://www.cisco.com/go/nms>

Cisco Services and Support

- Network Management Community at Cisco Support Forums:
 - <http://supportforums.cisco.com/>
 - <http://supportforums.cisco.mobi/>





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