Push vs. Pull in Web-Based Network Management

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Outline

- Problems with SNMP-based network management
- Proposed solution:
  - Web-based network management (HTTP, Java applets and servlets)
  - push model for regular management
  - pull model for *ad hoc* management
- Overview of JAMAP
- Conclusions

Today's management of IP networks

- SNMP frameworks (v1, v2c, v3)
  - manager-agent paradigm
  - polling (pull model)
  - notifications (push model)
- SNMP protocols (v1, v2c, v3)
- Network Management Platforms (NMPs): HP OpenView, Cabletron Spectrum, IBM/Tivoli Netview, Sun Solstice...

Mandatory tasks:	**Optional tasks:**
- network monitoring - data collection - notification handling	- configuration mgmt - inventory mgmt - ACLs mgmt - billing...

- Vendor- or device-specific add-ons (e.g. CiscoWorks)

Problems with NMPs (1/2)

- For customers:
  - too expensive (hardware and software):
    - ➠ dedicated hardware for network management
  - offer limited support for third-party RDBMSs
  - cost to migrate from Unix to Windows is too high:
    - ➠ Unix expertise required to maintain existing platforms
    - ➠ investment bound to processor & operating system
- For network equipment vendors:
  - the support of device-specific add-ons is too expensive:
    - ➠ many NMPs
    - ➠ many OSs
    - ➠ many add-ons

Problems with NMPs (2/2)

- For customers and network equipment vendors:
  - poor time-to-market for add-ons:
    - large vendors: several months after hardware release
    - startups: never --> need separate NMPs (no integrated management)
  - MIB versioning:
    - MIB upgrade in a network --> version mismatch between NMPand agents:
      - update NMP manually, device by device (no MIB-discovery protocol)
      - do not use new features of a MIB until all devices are upgraded

Problems with SNMP (1/2)

- SNMP expertise is scarce and expensive (esp. SNMPv3)
- Scalability, network overhead and latency are adversely affected by some early protocol design decisions (SNMPv1):
  - BER encoding
  - SNMP table retrieval mechanism (no `get-table`)
  - OIDs take much more space than values
  - no compression
- Low-level semantics:
  - aimed at instrumentation
  - no standard high-level APIs
  - site-specific network applications developed from scratch
  - bound to an NMP API, not a technology

Problems with SNMP (2/2)

- Security:
  - SNMPv1 and SNMPv2c: none; SNMPv3: not used yet
  - mgmt of remote subsidiaries (VPNs): expensive encryption hardware
  - firewalls: UDP relays
- Unreliable transport protocol:
  - important notifications (unacknowledged) are lost for silly reasons
  - SNMPv3 informs (acknowledged) are not used yet
  - important mgmt data requires retransmissions at the application level
- Distribution:
  - manager to manager: none (SNMPv2 M2M MIB obsolete)
  - manager to agent (mobile code): Script MIB not used yet
- Evolution hampered by legacy syst.: “better replace than repair”

Proposed Solution (1/2)

- Keep:
  - MIBs
  - organizational model
- Change management framework:
  - pull model --> push model for repetitive tasks
  - move some workload from the manager to the agents
- Change communication protocol:
  - SNMP --> HTTP
  - connectionless UDP --> persistent TCP connections
  - `gzip` compression
  - unlimited number of MIB variables per push cycle
  - BER encoding --> MIME parts + {strings, XML, ser. Java objects...}
  - natural table retrievals

Proposed Solution (2/2)

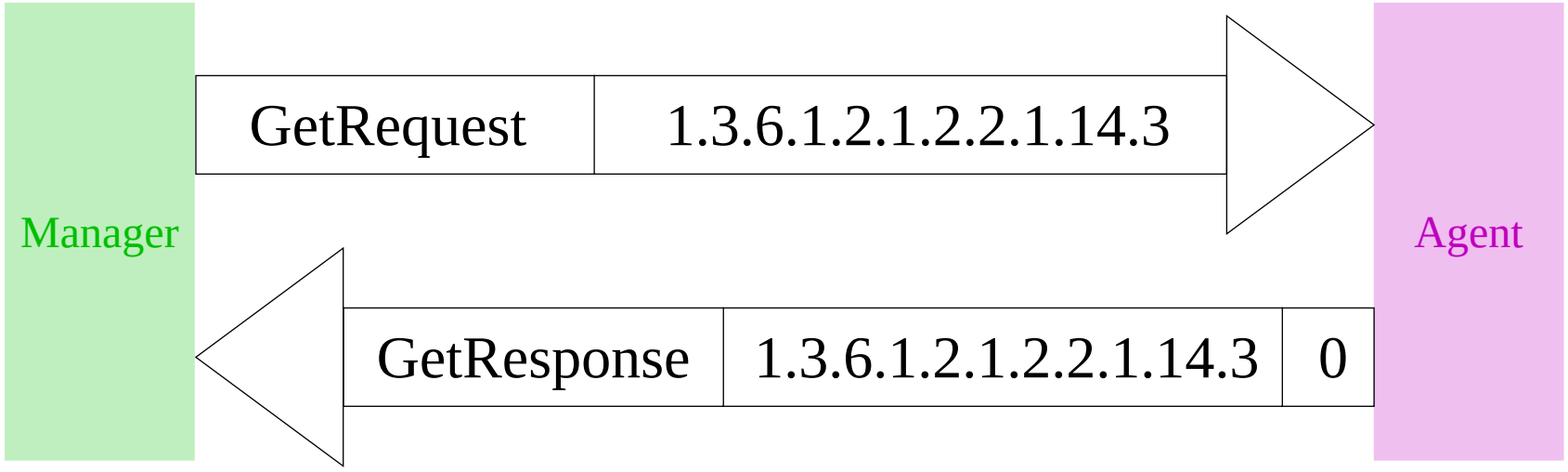
- Change NMP:
  - split manager:
    - management server (Java servlets)
    - management station (Web browser)
  - rewrite manager code: expensive binary software --> less expensive Java software (indep. of OS and proc., no RDBMS-specific glue code)
  - expensive specific add-ons --> less expensive standard Java applets
  - dedicated NMP hardware --> any hardware
  - few third-party RDBMSs --> any RDBMS via JDBC
  - distribution made easier:
    - manager: monolithic NMP --> distributed servlets
    - manager to manager: standard distributed Java application (future work)
    - manager to agent (mobile code): object serialization (future work)

Why HTTP Between Agents and Managers?

- Four techniques to distribute a Java application:
  - HTTP
  - sockets
  - RMI
  - Java IDL (CORBA)
- Distributed objects in network management (RMI or CORBA):
  - telecoms = yes
  - Internet = no (maybe later: EmbeddedJava --> lightweight RMI)
- HTTP > sockets:
  - natural communication between servlets within the mgmt server
  - same technology within the server and between agents and server
  - firewall setup easier for nonexperts (e.g. Web server = mgmt server)

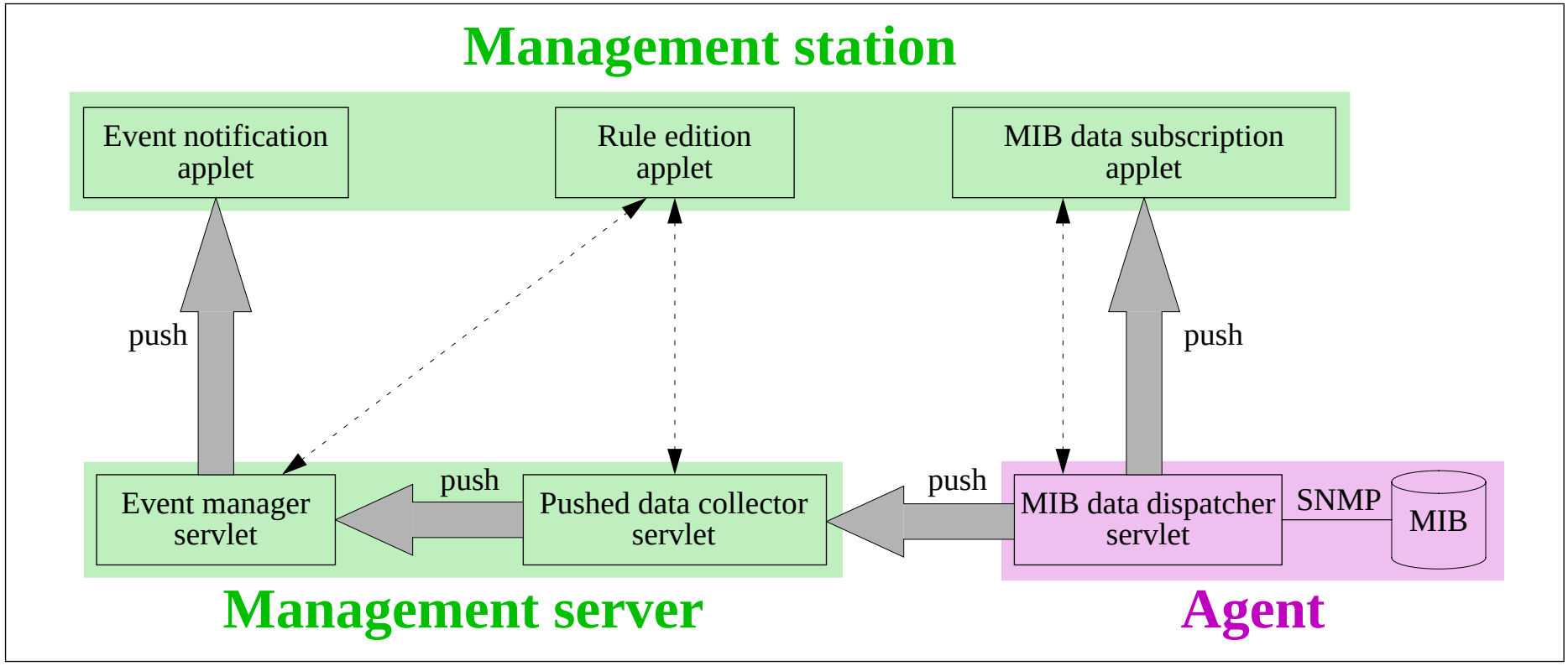
Why Use Push Technologies?

- Save bandwidth: decrease network overhead of mgmt data
- Example: error rate for inbound traffic through interface #3

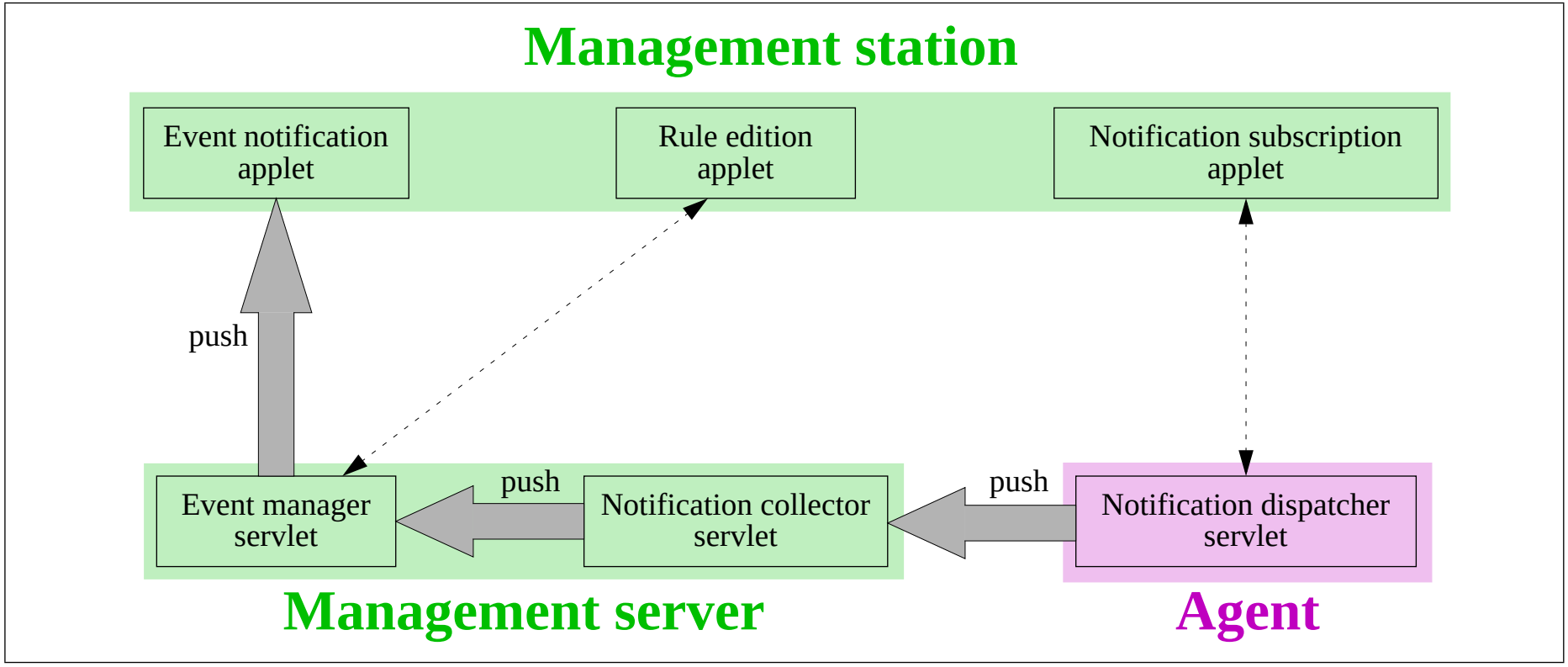


- Move some load from the manager to the agents
- Pave the way to Management by Delegation:
  - delegate preprocessing to the agents

JAMAP: Monitoring and Data Collection



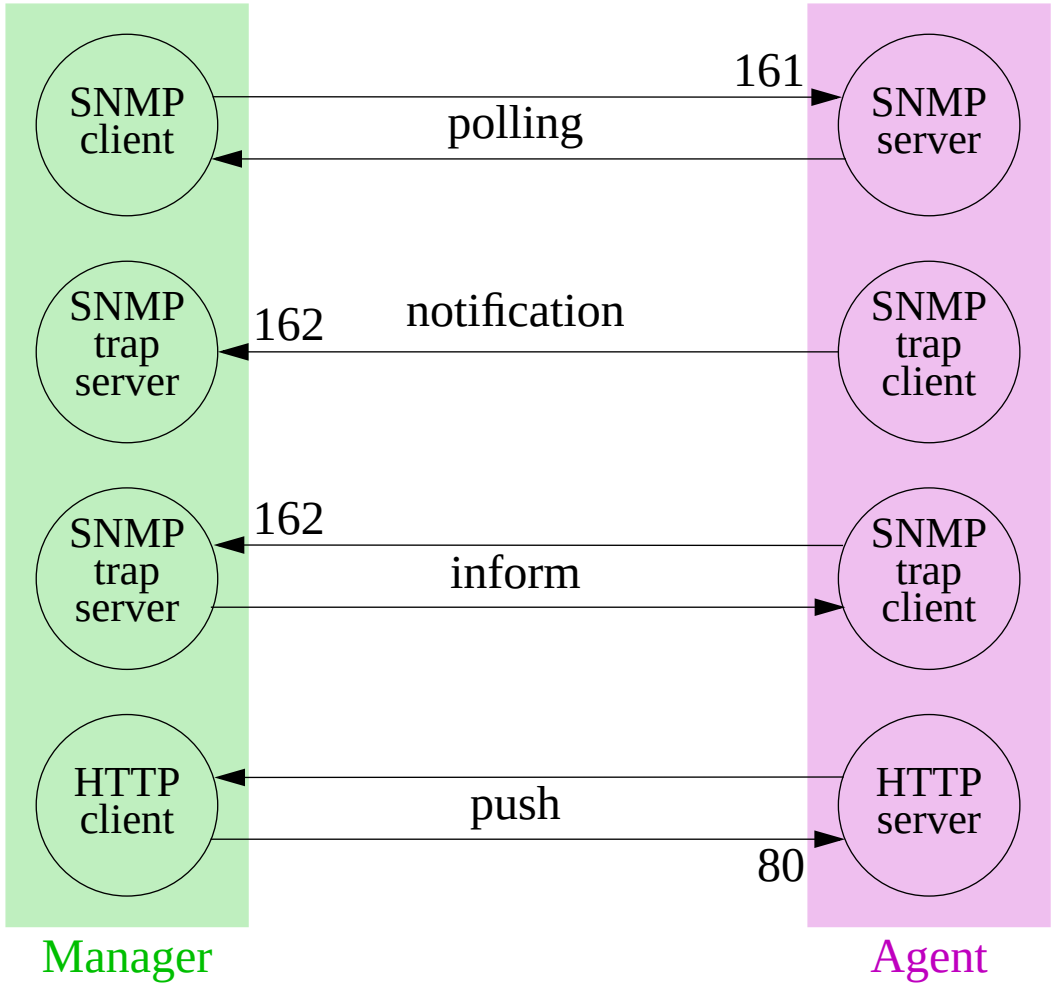
JAMAP: Notifications



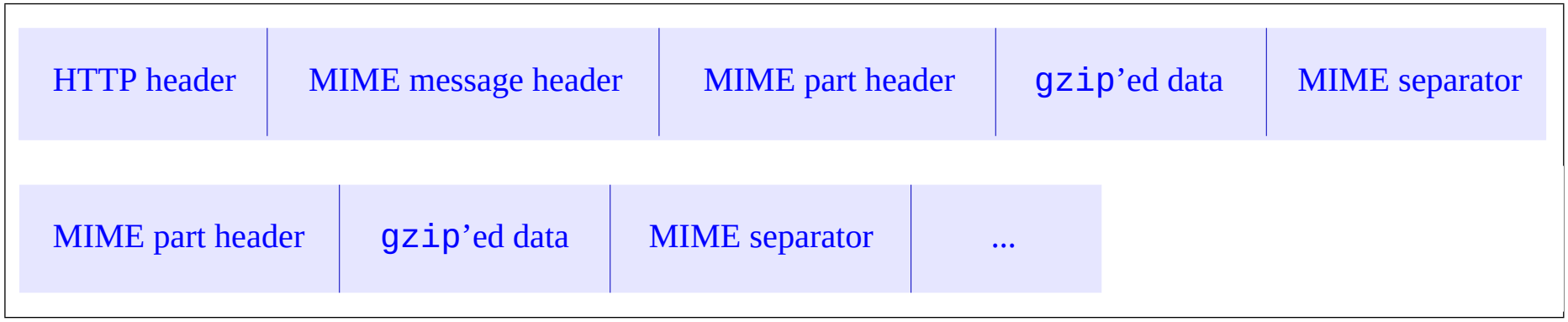
Issues

- Firewalls: connection should be created by internal manager, not external agent
- Ensure persistent connections:
  - the agents must control the timeout value of their embedded HTTP server
  - the manager must reconnect in case of connection teardown
- Positions of client and server now reversed:
  - transfer of management data initiated by the agent
  - client side of the persistent connection still on the manager side
  - we want the server to initiate a transfer in a client-server architecture!

Positions of Client and Server Now Reversed



HTTP and MIME



MIME = Multipurpose Internet Mail Extensions

- Advantages:
  - simple to implement
  - firewalls: minor change (assuming Web access already)
- Drawbacks:
  - the manager must detect a network outage to set up a new connection:
    - ➠ send keepalives if no data after 9 minutes
    - ➠ blind during 9 minutes, or send keepalives more often

Conclusions (1/2)

What do we gain by going from SNMP-based pull to Java-based push to manage IP networks?

- Get rid of the expensive NMP
- Use well-known Web technologies instead of domain-specific SNMP
- Reduce network overhead of management data
- Reduce development costs of add-ons
- Zero the time-to-market of add-ons (embedded)
- Put small and large equipment vendors in fair competition w.r.t. integrated management
- Simplify the management of remote subsidiaries across a firewall
- Improve the support for third-party RDBMSs
- Remain backward compatible by using proxies for legacy systems

Conclusions (2/2)

What does it cost to go from SNMP-based pull to Java-based push to manage IP networks?

- network equipment vendors must add software to their equipment:
  - HTTP server (usually done today)
  - push system
  - scheduling system
  - JDK (JVM)
- administrators need to synchronize the clocks of the managers and the agents (e.g. with NTP)
- we need professional-grade software for the manager:
  - more and more vendors in the Web-based management market