Web services in Twente

- Thomas Drevers: Performance, compared to SNMP
- Willem Wong: WS in mobile “phones”
- Hoda El Merabet: Application: “MRTG” in MS-Excel
- Pierre Humbert: Configuration: WS-Transactions
- Jeroen van Sloten: From SMI -> WSDL (MDA)
- + Others

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Performance of web services compared to traditional SNMP

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Overview

- **Introduction**
  - **Motivation**
  - **Performance**
- Measurements
- Results
- Concluding remarks
- Questions

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Motivation

- September 2002: IRTF-NMRG Osnabrück
- Web services versus SNMP
- Questions concerning web services performance
- We wanted to investigate this, and provide real figures

Performance

The performance is divided into three main areas

- Network usage
- System resource usage
  - CPU
  - Memory
- Total time of the operation

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Measurements (1/5)

What is shown

- Figures that compare SNMP and web services implementation
- Two types of web services
  - Standard web services
  - Web services which use compression
- Two types of SNMP
  - Always: UDP
  - Sometimes: TCP

Measurements (2/5)

Implementation

- Net-SNMP
  limited MIBs
- gSOAP
  with Net-SNMP Data retrieval functions

Measurements (3/5)

Network usage

- For every operation two measurements are performed:
  1. Data in: IP + TCP/UDP + SOAP/SNMP layers
  2. Data in: the SOAP/SNMP layer

Measurements (4/5)

System resource usage

- Two kind of measurements:
  - CPU time consumption
  - Memory consumption
- CPU time consumption
  - Data retrieval
  - XML / BER processing (encoding / decoding)
- Memory consumption
  - program code
  - Permanent memory allocation (static)
  - Additional memory per operation (dynamic)

Measurements (5/5)

Total operation time

– The average amount of time the client has to wait until an operation is finished

Measured Data: Model

If Table

ifIndex	ifDescr	ifMTU	ifSpeed	Etc …
1	Lo		10000000	
2	Eth0		100000000	
3	Eth1		0	

Measured Data: WSDL variants

- Cell
- Column
- Row
- Columns
- Table

Measured Data: WSDL Table (1)

```
<complexType name="ifEntry">
 <sequence>
  <element name="ifIndex" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifDescr" type="xsd:string" minOccurs="1" maxOccurs="1" nillable="true"/>
  <element name="ifType" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifMtu" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifSpeed" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifPhysAddress" type="xsd:string" minOccurs="1" maxOccurs="1" nillable="true"/>
  <element name="ifAdminStatus" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifOperStatus" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifLastChange" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifInOctets" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifInUcastPkts" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifInDiscards" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifInErrors" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifInUnknownProtos" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifOutOctets" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifOutUcastPkts" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
  <element name="ifOutErrors" type="xsd:unsignedInt" minOccurs="1" maxOccurs="1"/>
 </sequence>
</complexType>
```

Measured Data: WSDL Table (2)

```
 <complexType name="GetIfTableResponse">
  <sequence>
   <element name="ifEntry" type="utMon:ifEntry" minOccurs="1" maxOccurs="unbounded"/>
  </sequence>
 </complexType>

<message name="GetIfTableRequest">
 <part name="commuity" type="xsd:string"/>
</message>

<message name="GetIfTableResponse">
 <part name="-sizeTable" type="xsd:int"/>
 <part name="ifEntry" type="utMon:ifEntry"/>
</message>

<portType name="GetIfTableServicePortType">
 <operation name="GetIfTable">
  <documentation>Service definition of function utMon__GetIfTable</documentation>
  <input message="tns:GetIfTableRequest"/>
  <output message="tns:GetIfTableResponse"/>
 </operation>
</portType>
```

Measured Data: C Structure Table

```
struct  ifEntry
{                                                   // list of names and values, values may be NULL
        xsd__unsignedInt        ifIndex;                    // interface index number
        xsd__string             ifDescr;                    // interface description
        xsd__unsignedInt        ifType;                     // Interface type
        xsd__unsignedInt        ifMtu;                      // maximum packet size
        xsd__unsignedInt        ifSpeed;                    // maximum speed
        xsd__string             ifPhysAddress;              // Physical address of the interface (eg MAC)
        xsd__unsignedInt        ifAdminStatus;              // preferred status set by admin (1=up, 2=down, 3=testing)
        xsd__unsignedInt        ifOperStatus;               // operational status of the interface
        xsd__unsignedInt        ifLastChange;               // Sysuptime of last change in operational staus
        xsd__unsignedInt        ifInOctets;                 // octets received by the interface
        xsd__unsignedInt        ifInUcastPkts;              // unicast packets received
        xsd__unsignedInt        ifInDiscards;               // Discarded incoming packets
        xsd__unsignedInt        ifInErrors;                 // Erronous incoming packets
        xsd__unsignedInt        ifInUnknownProtos;          // Amount of packets dicarded because of unknown protcols
        xsd__unsignedInt        ifOutOctets;                // number of outbound octets
        xsd__unsignedInt        ifOutUcastPkts;             // number of outbound unicast packets
        xsd__unsignedInt        ifOutErrors;                // number of packets/units whch could not be transmitted
};
```

Measured Data: SNMP variants

For SNMP the same variants as with WSDL are used

- Cell retrieves a single cell
  - Uses the snmpget method
- Column retrieves a single column
  - Uses the snmpgetbulk method with a maximum for the amount of rows
- Row retrieves a single row
  - Uses a single snmpget method, with a request for each cell in the row
- Columns retrieves specified columns
  - Uses the snmpgetbulk method with a request for each column and a maximum corresponding to the amount of rows
- Table retrieves complete table
  - Uses a series of the snmpgetbulk methods to retreive the whole table

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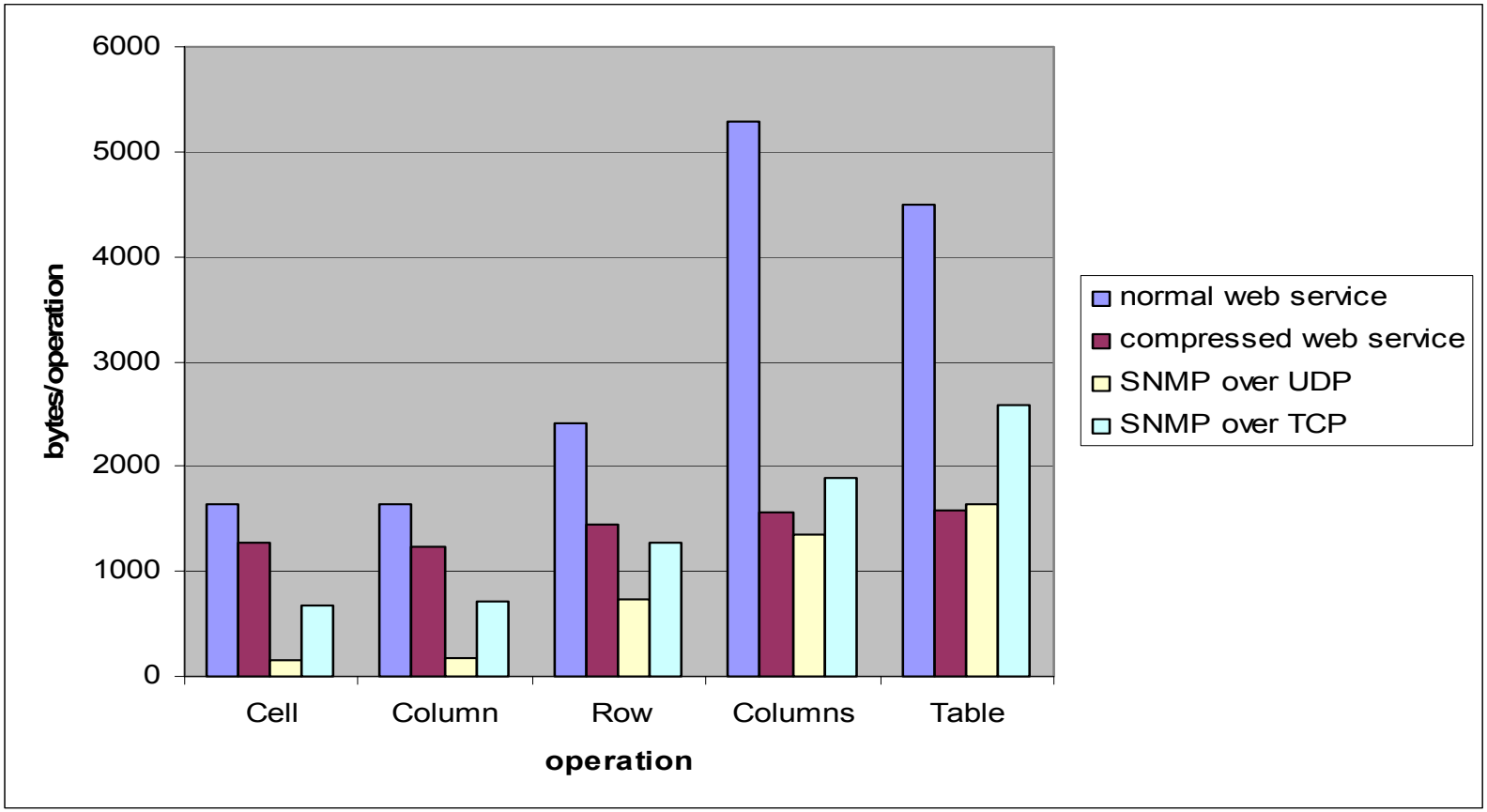
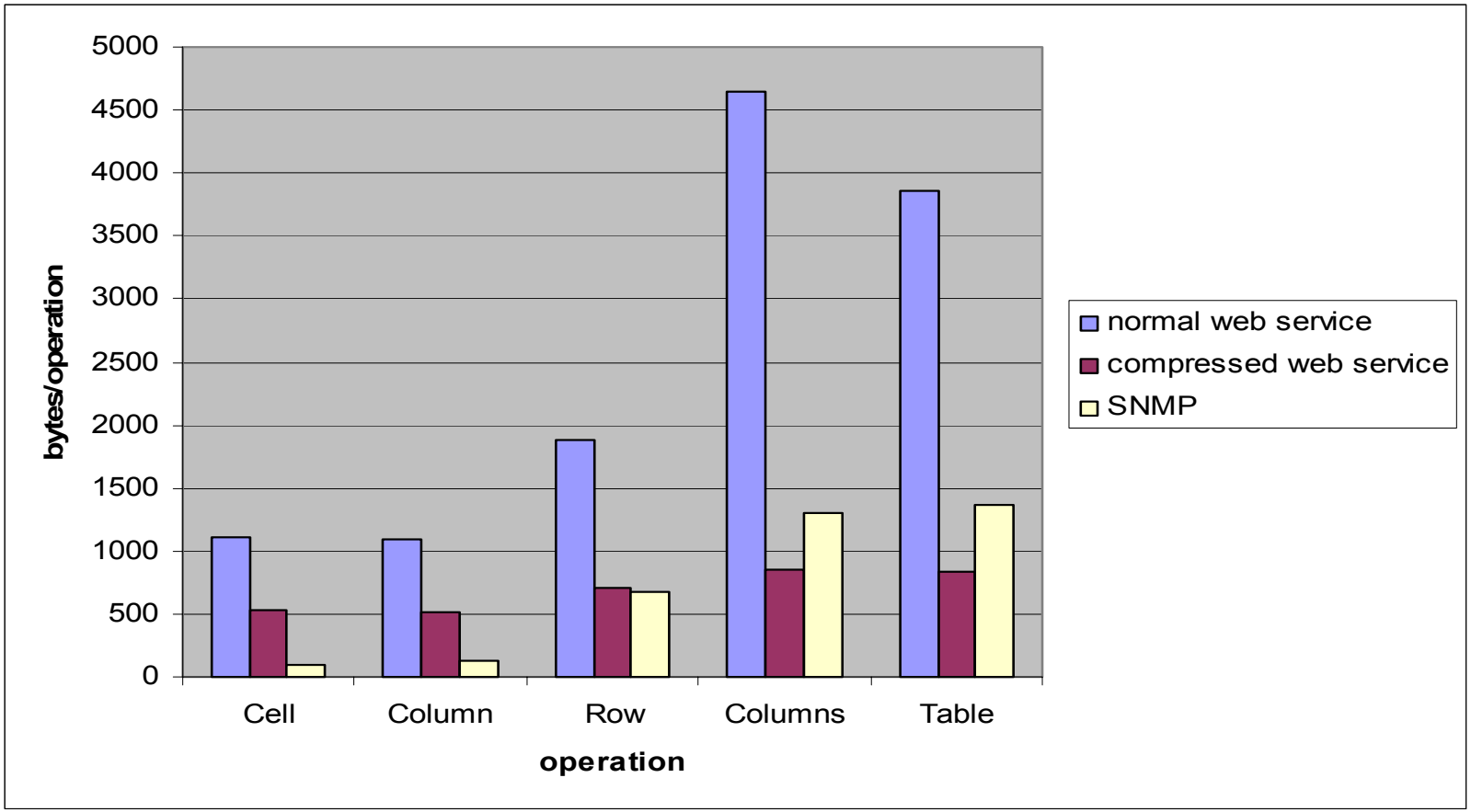
Network usage (1/4)



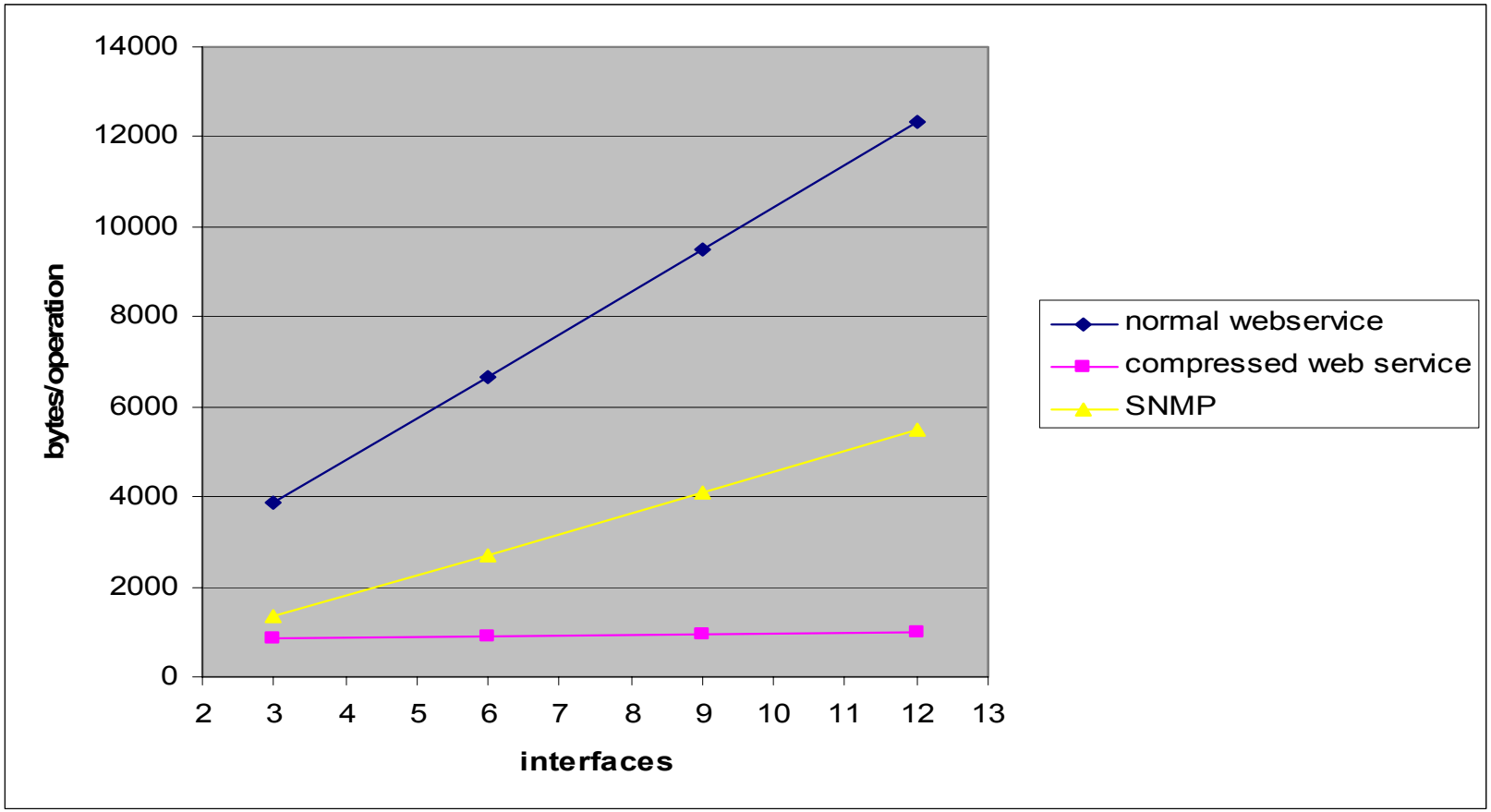
IP and higher layer protocols

Network usage (2/4)



SOAP and SNMP protocols

Network usage (3/4)



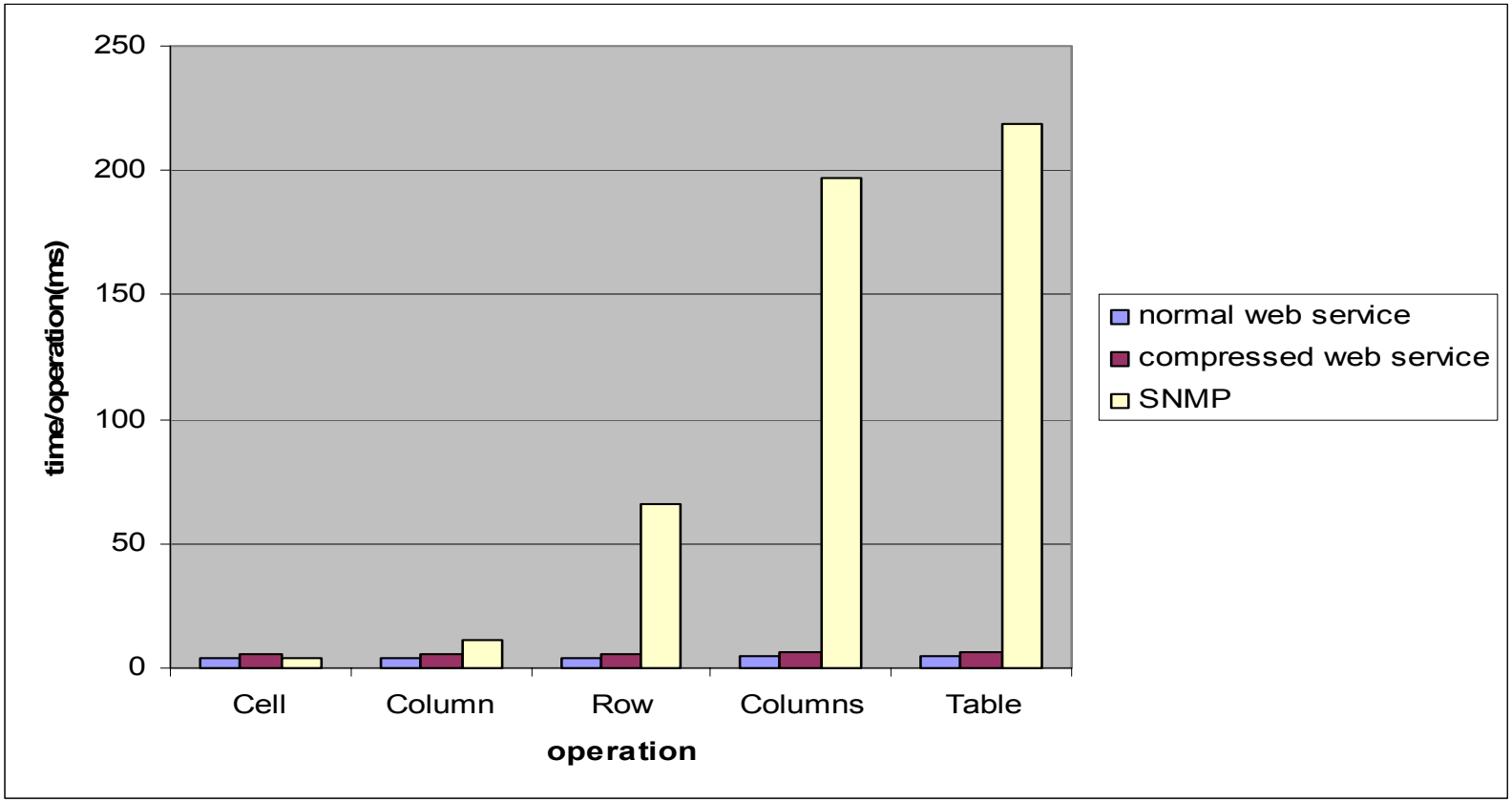
Effect of more data (extra interfaces)

Network usage (4/4)

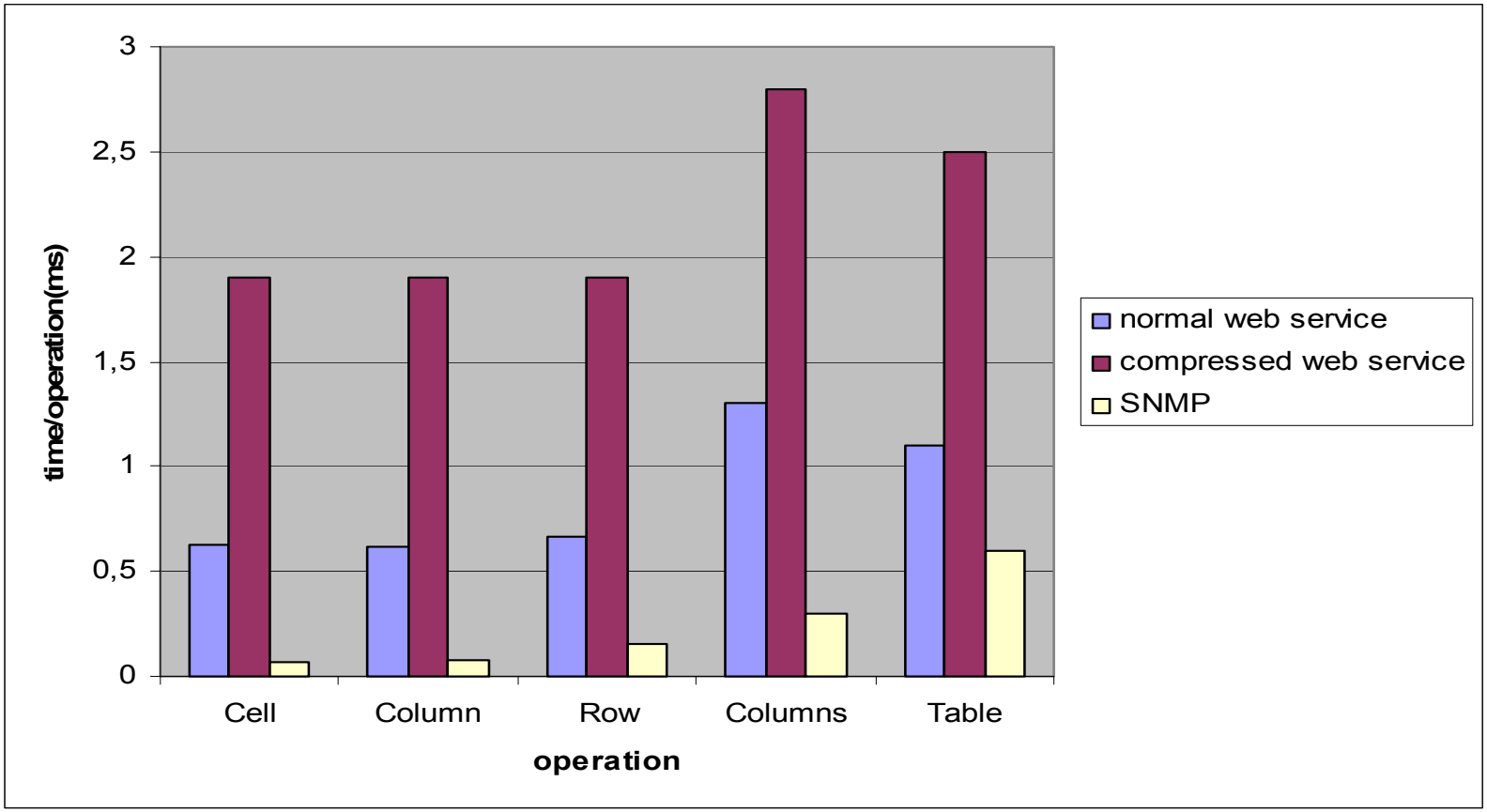
Conclusion

- For small amounts of data, SNMP is more efficient
- For large amounts of data, compressed web services are more efficient
- Uncompressed web services are not very efficient

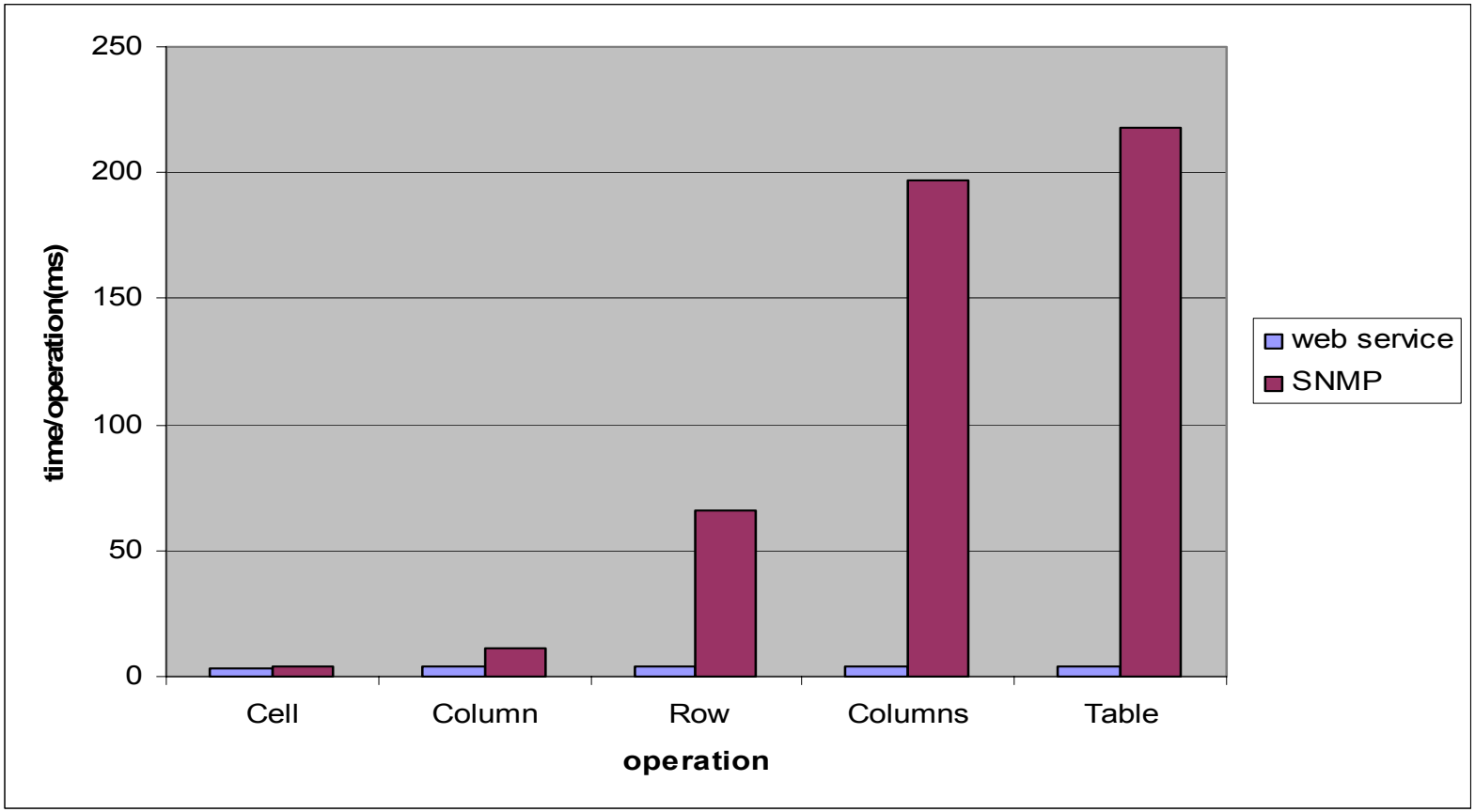
CPU usage


250
200
150
100
50
0
time/operation(ms)
Cell
Column
Row
Columns
Table
operation
normal web service
compressed web service
SNMP

CPU usage: Encoding and Decoding



CPU usage: Data Retrieval



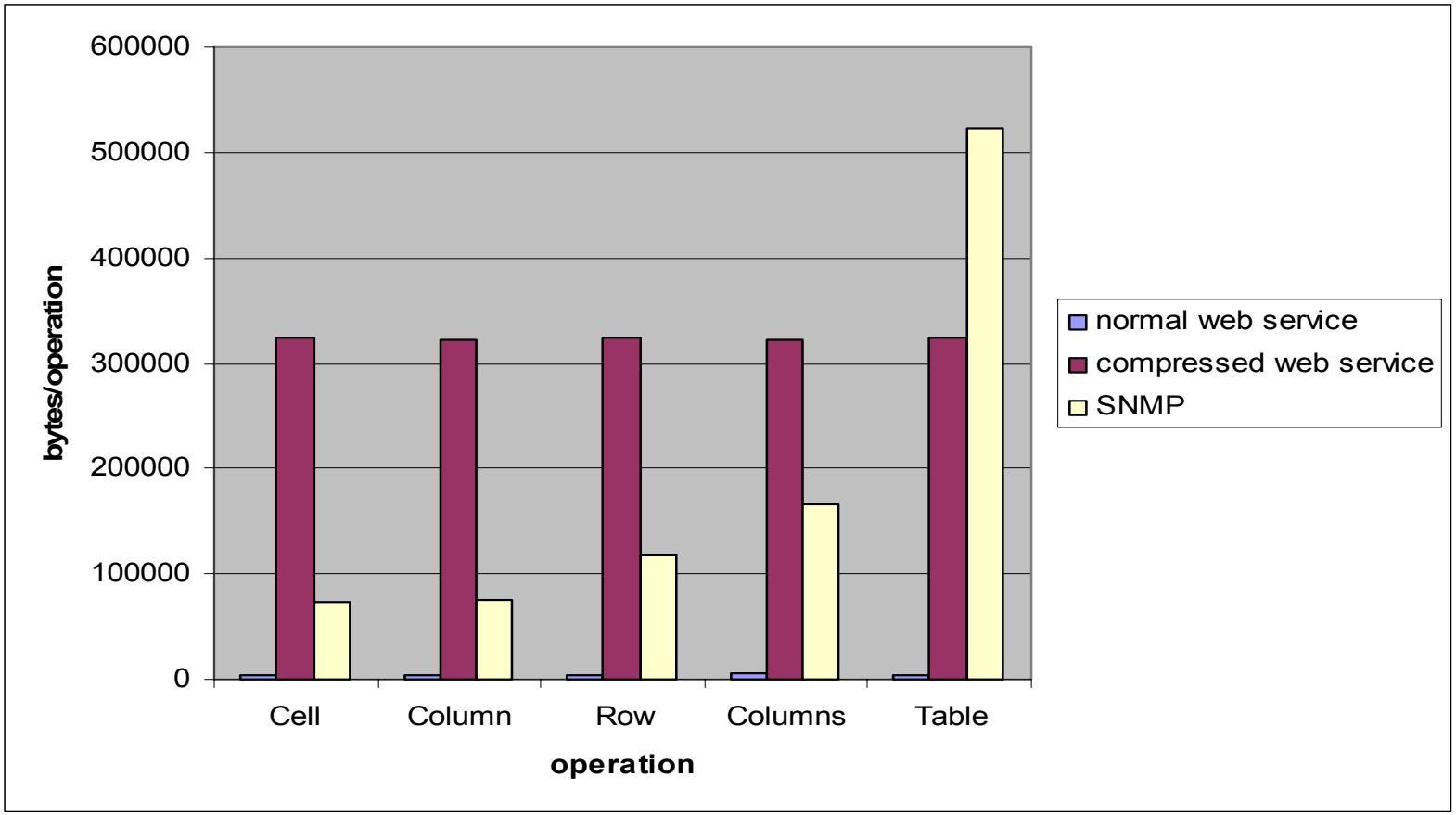
CPU usage: Conclusions

- CPU usage primarily depends on data retrieval
- Our Web services implementation far better then (Net-)SNMP
- CPU usage of (Net-)SNMP grows linearly with the number of cells
- CPU usage of web services does not depend on the number of cells
- Compression takes roughly twice the time of normal encoding / decoding

Memory usage: static

- Program footprint
  - Approximately 1972 Kbyte for SNMP
  - Approximately 580 Kbyte for web services
- Amount of memory always allocated for data
  - SNMP 128 Kbyte
  - Web services 470 bytes

Memory usage: dynamic

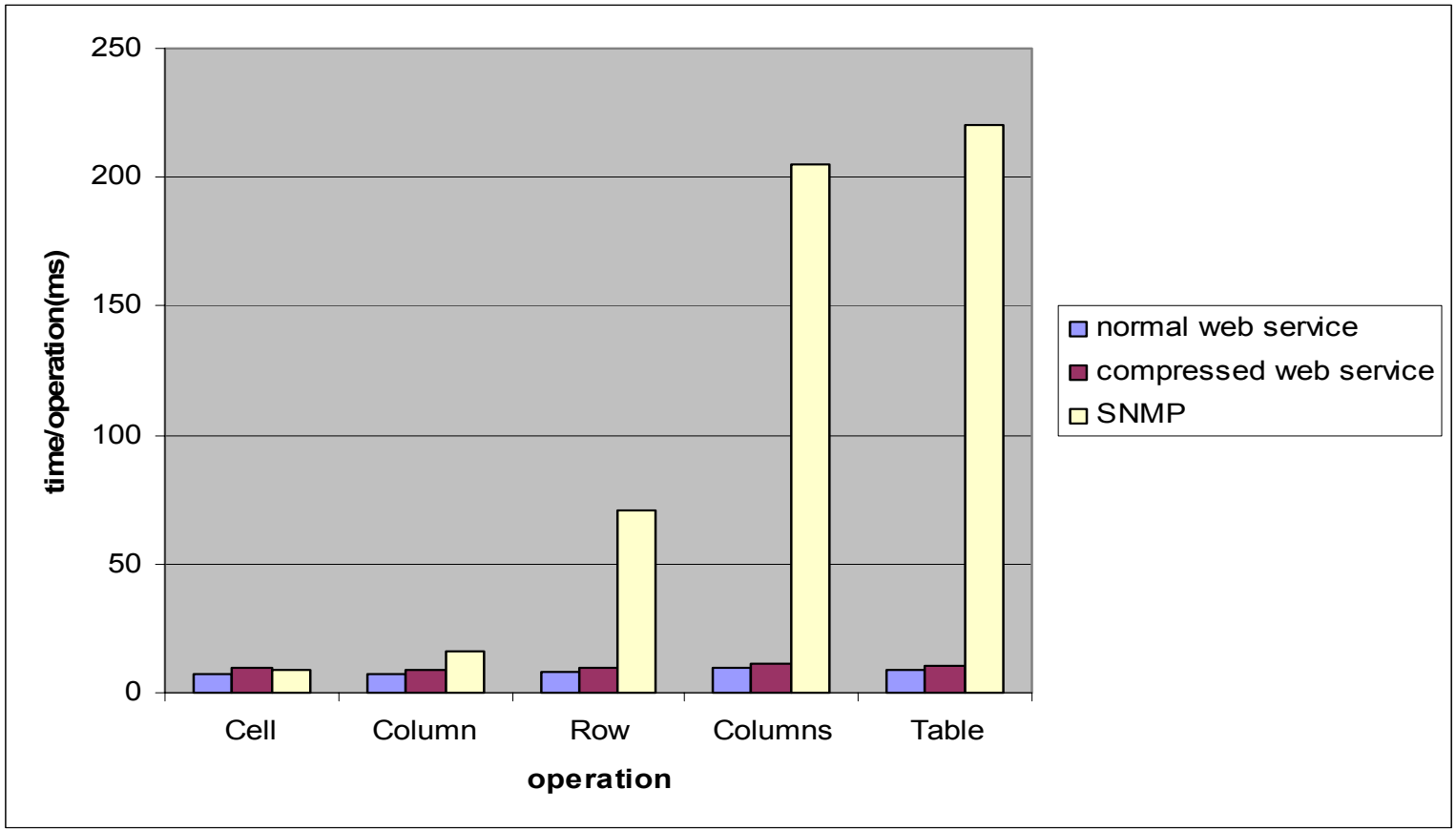


Memory usage: conclusions

Conclusion

- Net-SNMP uses more memory than our gSOAP web service implementation
- However, Net-snmp offers more functionality: comparison is therefore unfair

Total operation time



Total operation time: conclusions

- Web services is much faster
- SNMP spends most of its time on (inefficient) data retrieval
- Message processing is not really the bottleneck

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Concluding remarks

- In our case study, performance of web services was better than SNMP, particularly when large amounts of data were retrieved
- The results will likely depend on the specific implementations
- Researchers who use performance as the reason to reject web services technology, make a mistake

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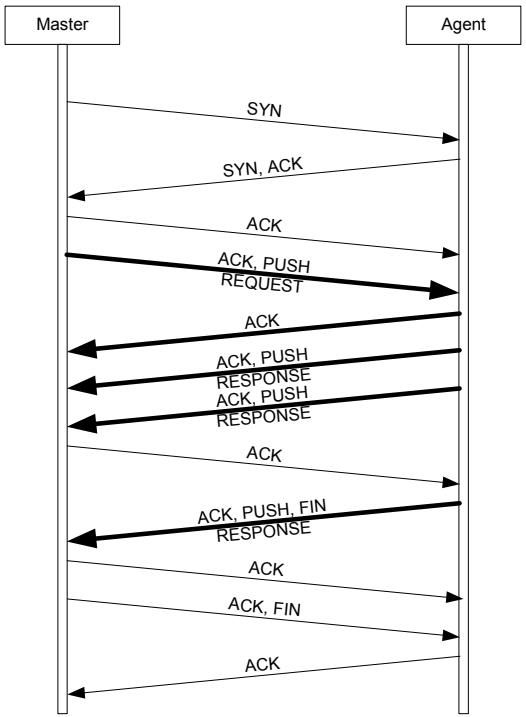
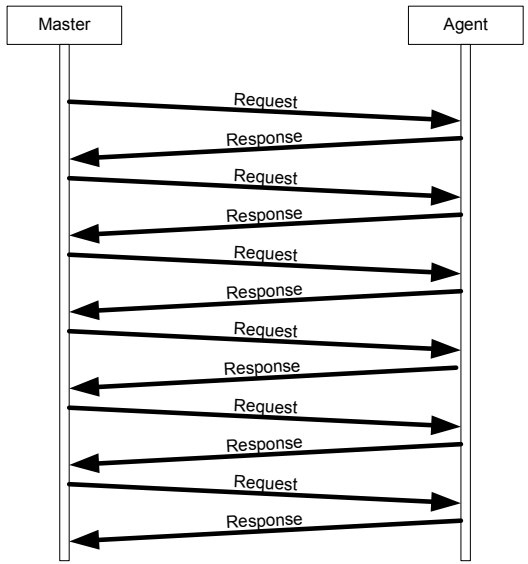
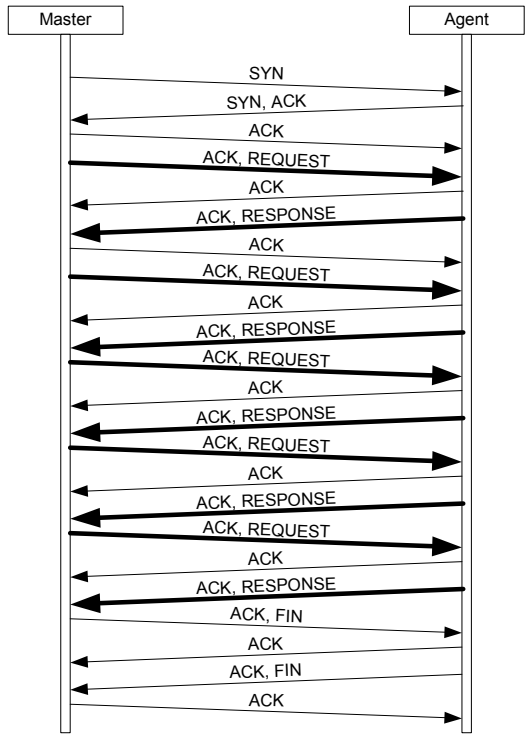
BACKGROUND INFO: Message sequence



Web service message sequence



SNMP over UDP message sequence



SNMP over TCP message sequence