
Performance Evaluation of XML-based Network Management

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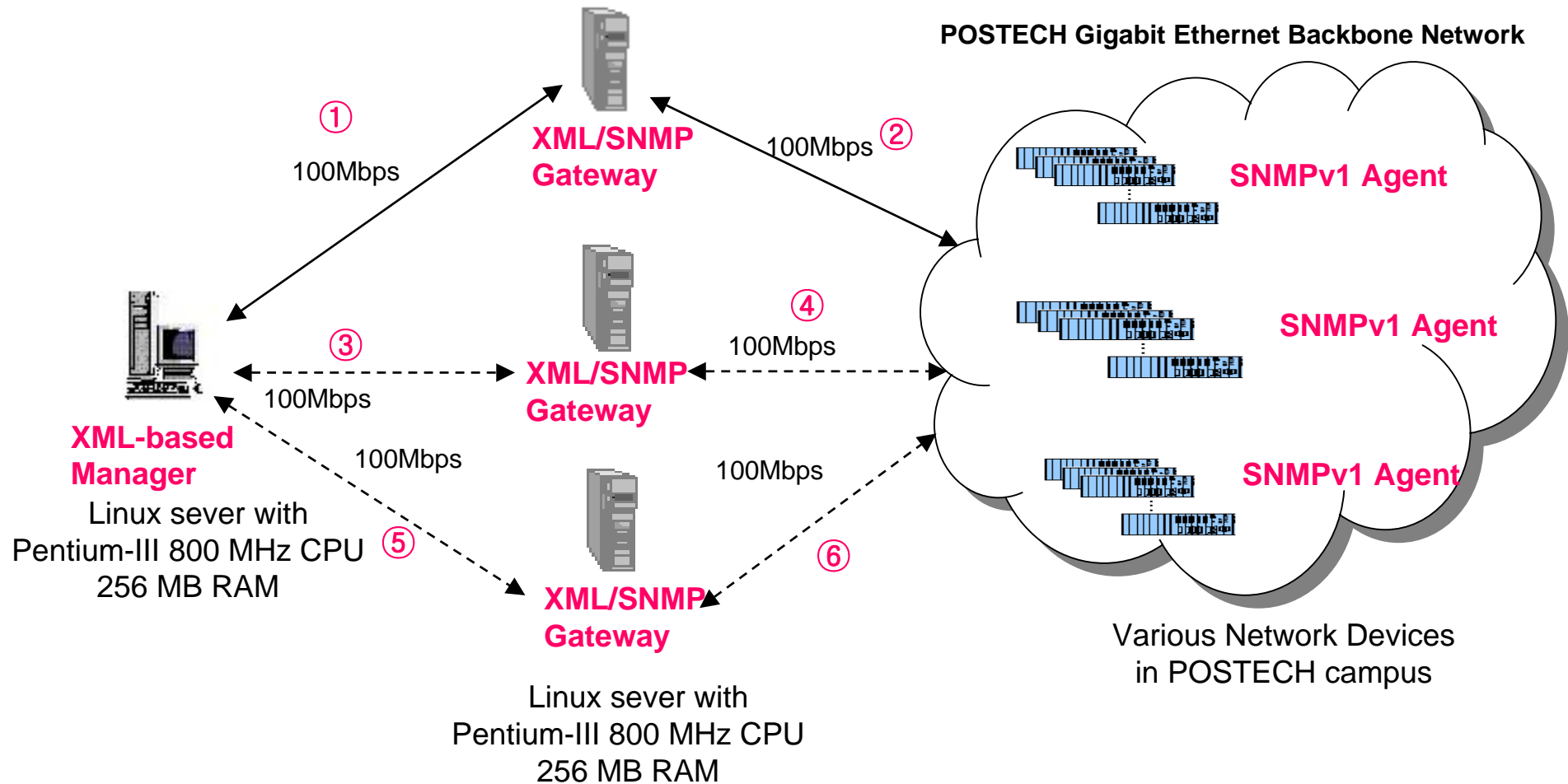
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Introduction

- ❖ XML-based network management is actively in progress
 - XML/SNMP gateway
 - Configuration management of network devices
 - Architecture for XML-based network management
 - ❖ Performance of XML-based NM is not validated
 - Network bandwidth to transfer the XML data is large because XML is text-based and transferred over HTTP/TCP
 - Processing overhead of XML-based manager and XML/SNMP gateway is not known
 - Due to insufficient implementation
- ➔ Provide a performance evaluation of XNMS

Test Environment



Performance Evaluation Items (1)

❖ Network Traffic Volumes

- Network traffic between XML-based manager and XML/SNMP gateway (i.e., ①) vs. network traffic between gateway and SNMP agents (i.e., ②)
- Network traffic according to the number of SNMP agents (1 to 100) and the number of XML/SNMP gateways (1 to 3)
- 2 gateways: network traffic (①+③), 3 gateways: network traffic (①+③+⑤)

❖ Response Times

- Response time between XML-based manager and XML/SNMP gateway (i.e., ①) vs. response time between gateway and SNMP agents (i.e., ②)
- Response time according to the number of SNMP agents (1 to 100) and the number of XML/SNMP gateways (1 to 3)
- 2 gateways: response time (②+④), 3 gateways: response time (②+④+⑥)

Performance Evaluation Items (2)

❖ Resource Usage

- CPU usage and memory usage of XML-based manager
- CPU usage and memory usage of XML/SNMP gateway
- Resource usage according to the number of SNMP agents (1 to 100) and the number of XML/SNMP gateways (1 to 3)

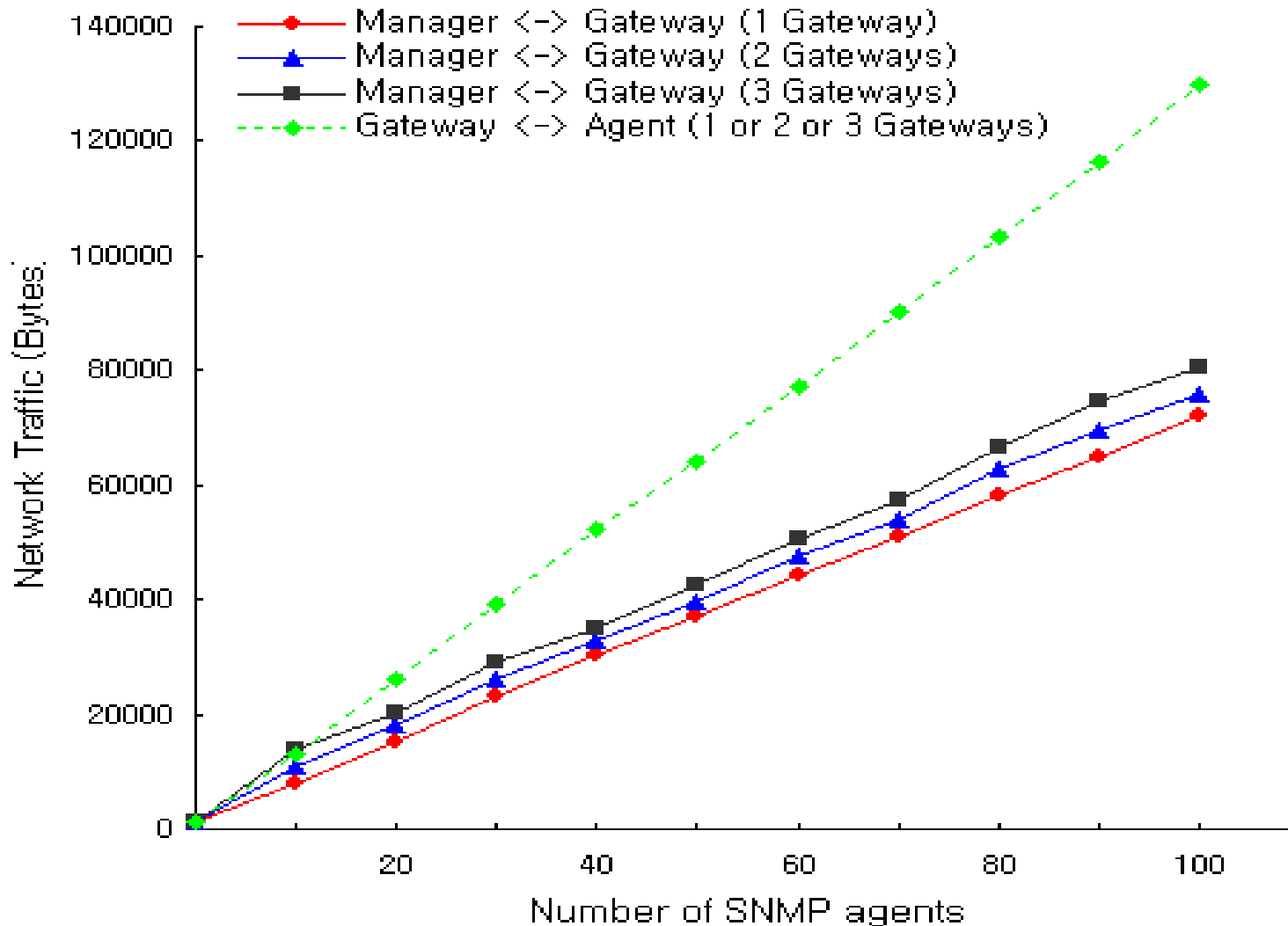
❖ Get Operation: SNMP MIB-II System Group

Network Traffic of Get for MIB-II System Group

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	Manager ↔ Gateway	1313	8021	15372	23116	30310	37102	44129	51124	58198	65149	72310
	Gateway ↔ Agent	1294	12986	26037	39098	52094	64091	77212	90214	103301	116428	129702
2	Manager ↔ Gateway	1313	11001	17985	25972	32981	39512	47621	53942	62879	69432	75964
	Gateway ↔ Agent	1294	12986	26037	39098	52094	64091	77212	90214	103301	116428	129702
3	Manager ↔ Gateway	1313	13997	20342	28972	35129	42601	50723	57212	66462	74827	80489
	Gateway ↔ Agent	1294	12986	26037	39098	52094	64091	77212	90214	103301	116428	129702

(Unit: Bytes)

Network Traffic of Get for MIB-II System Group

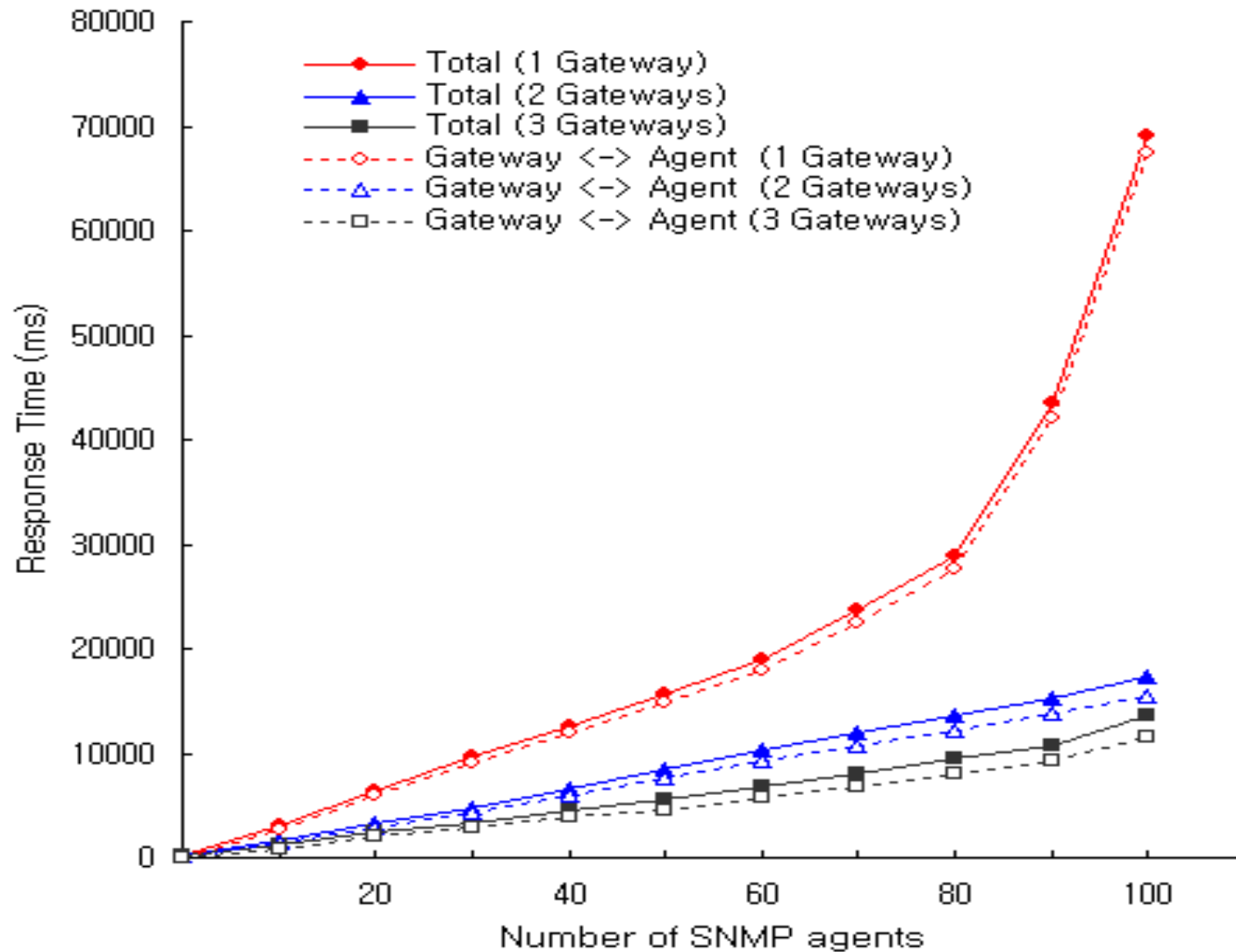


Response Time of Get for MIB-II System Group

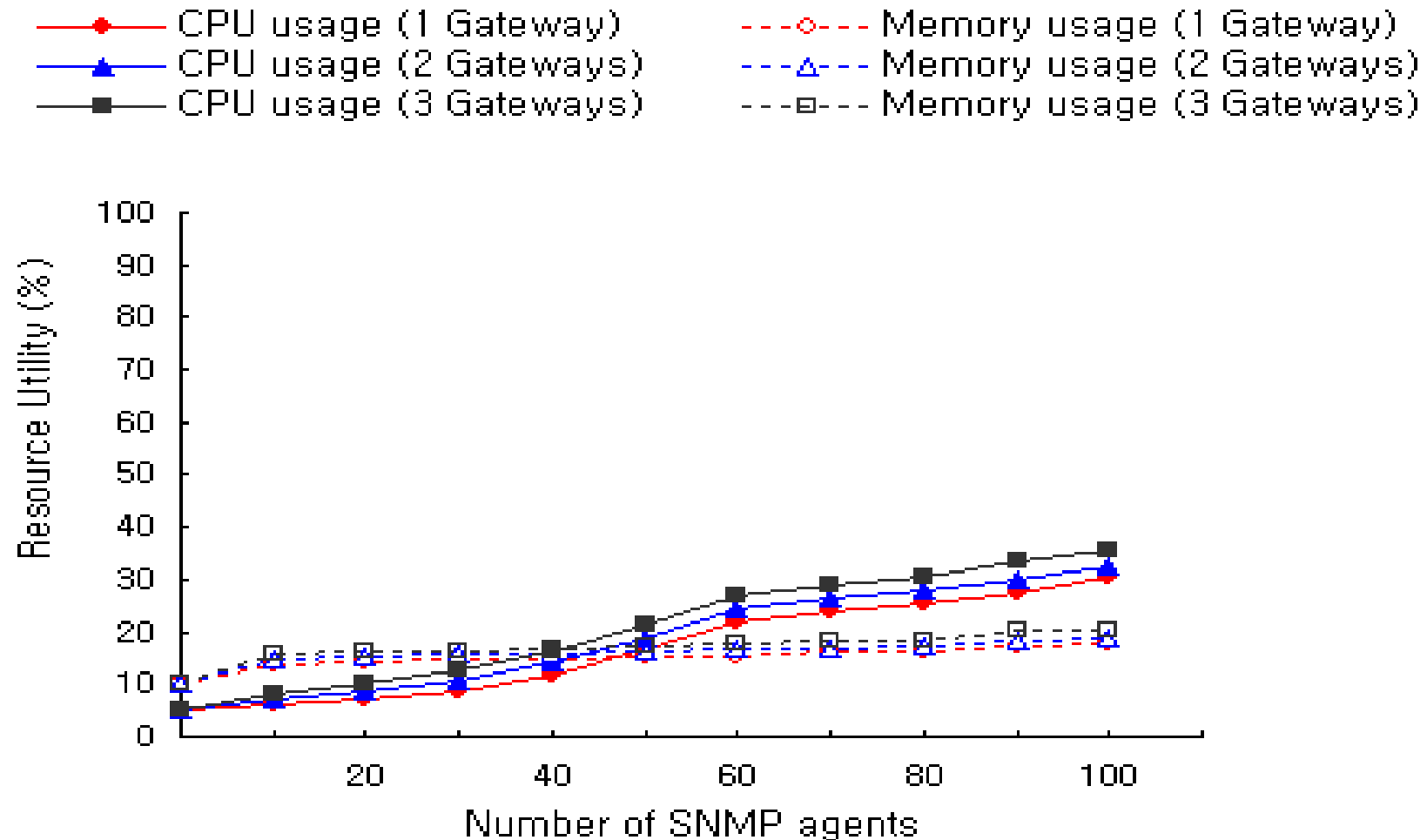
# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	Manager ↔ Gateway	268	305	382	487	605	886	970	1154	1378	1505	1705
	Gateway ↔ Agent	21	2750	5974	9147	12060	14823	18024	22495	27566	42062	67435
	Total	289	3055	6356	9634	12665	15709	18994	23649	28944	43567	69140
2	Manager ↔ Gateway	270	310	376	490	642	905	987	1204	1440	1510	1908
	Manager ↔ Gateway	21	1405	2948	4346	6027	7528	9295	10770	12248	13728	15495
	Total	291	1715	3324	4836	6669	8433	10282	11974	13688	15238	17403
3	Manager ↔ Gateway	268	312	380	494	640	890	989	1215	1396	1518	1898
	Manager ↔ Gateway	22	926	1995	2812	3818	4614	5719	6826	8012	9239	11649
	Total	290	1238	2375	3306	4458	5504	6708	8041	9408	10757	13547

(Unit: ms)

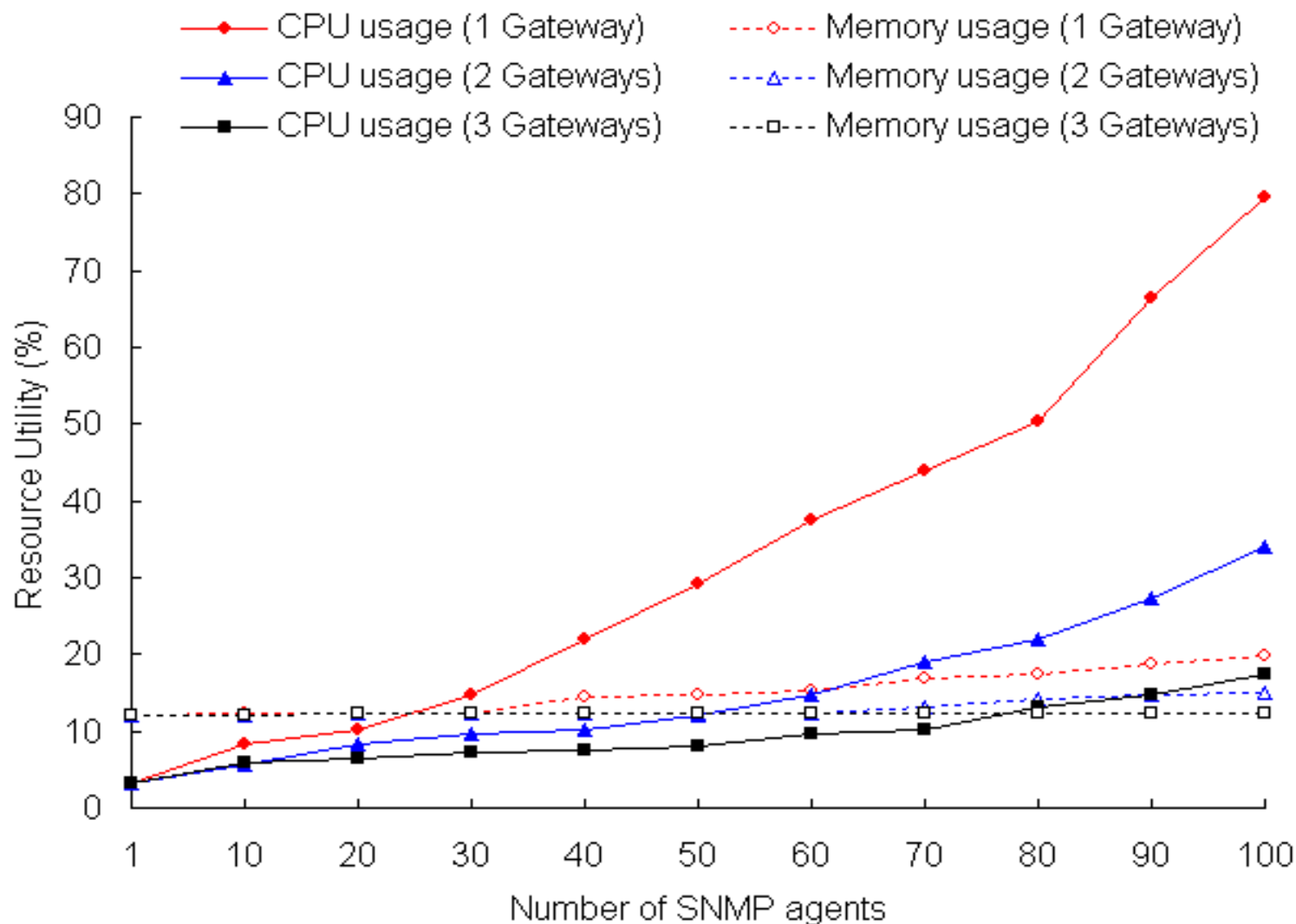
Response Time of Get for MIB-II System Group



Resource Usage of XML-based Manager



Resource Usage of XML/SNMP Gateway



Response Time depending on Computing Resource

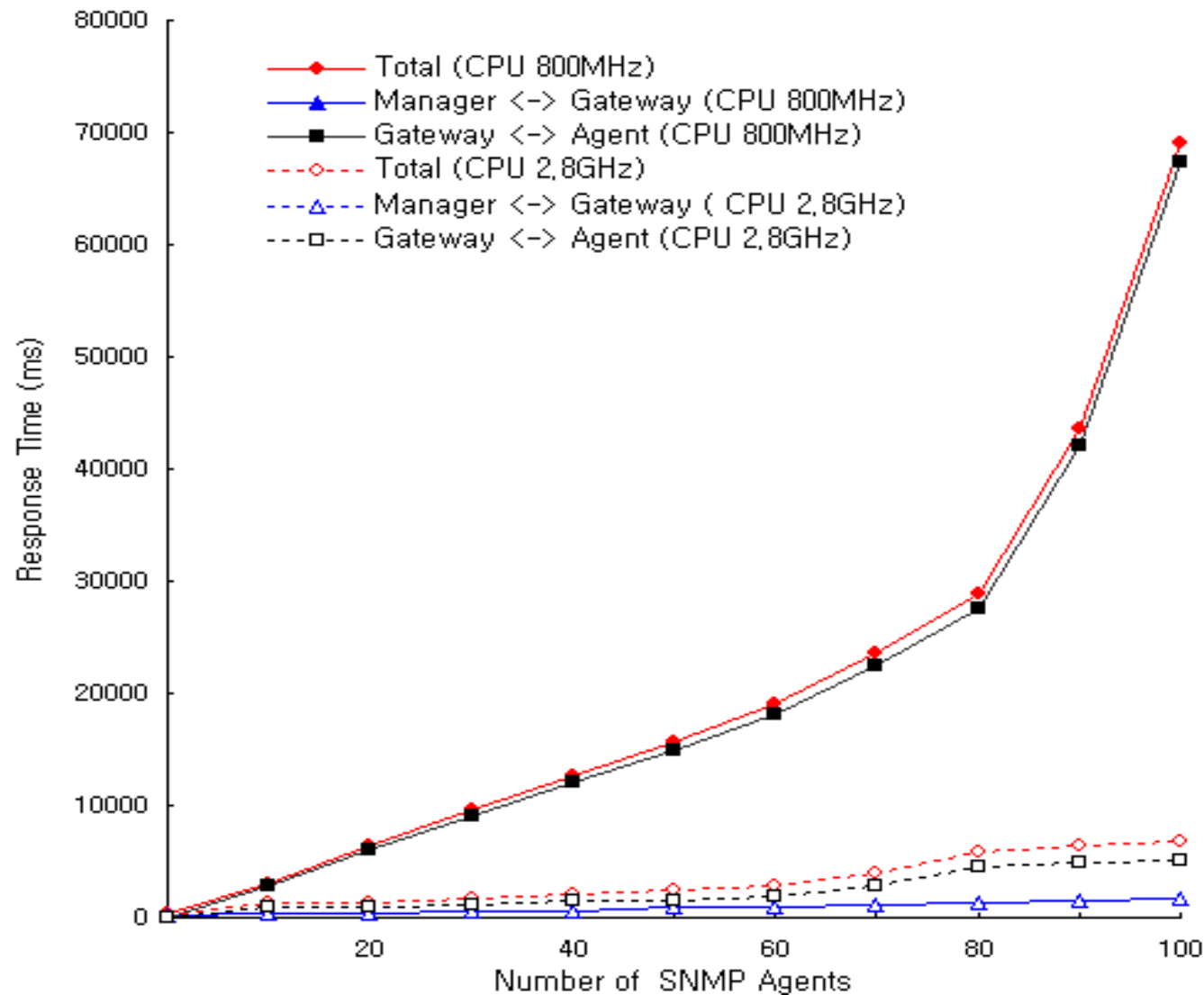
# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1 (CPU 800MHz, 256MB)	Manager ↔ Gateway	268	305	382	487	605	886	970	1154	1378	1505	1705
	Gateway ↔ Agent	21	2750	5974	9147	12060	14823	18024	22495	27566	42062	67435
	Total	289	3055	6356	9634	12665	15709	18994	23149	28944	43567	69140

MIB-II System Group (Unit: ms)

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1 (CPU 2.8GHz, 512MB)	Manager ↔ Gateway	262	305	382	487	605	856	970	1154	1378	1505	1705
	Gateway ↔ Agent	18	939	1032	1180	1420	1545	1844	2897	4479	4907	5016
	Total	280	1244	1414	1667	2025	2401	2814	4051	5857	6412	6721

MIB-II System Group (Unit: ms)

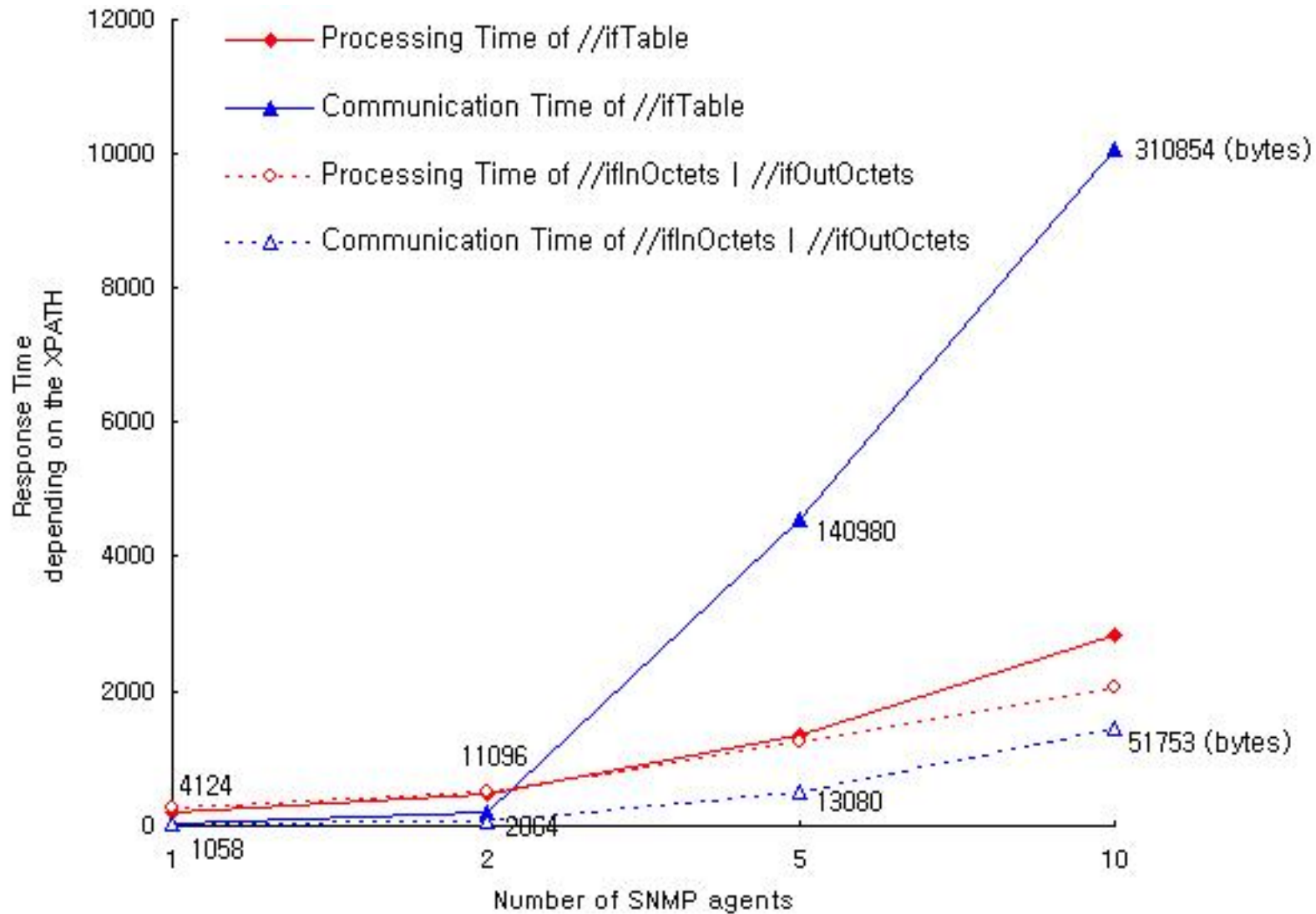
Response Time depending on Computing Resource



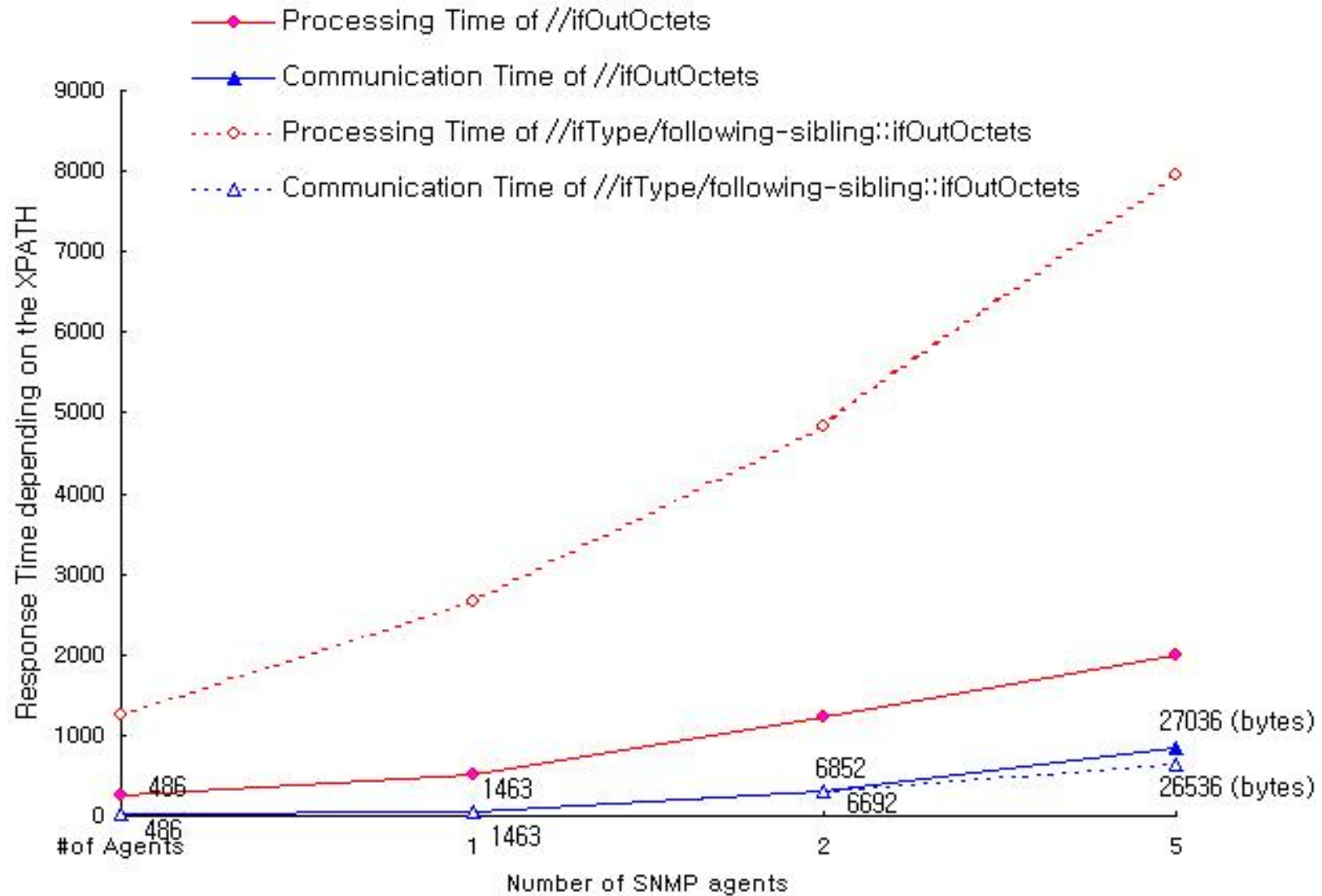
Processing Time depending on XPath Expression (1)

XPath	# of SNMP Agents		1	2	5	10
//ifTable	Gateway ↔ Agent	Processing (ms)	211	480	1368	2856
		Communication (ms)	45	127	4541	10063
		Traffic (bytes)	4124	11096	140980	310854
//ifInOctets //ifOutOctets	Gateway ↔ Agent	Processing (ms)	265	518	1267	2075
		Communication (ms)	24	62	496	1459
		Traffic (bytes)	1058	2864	13080	51753
//ifOutOctets	Gateway ↔ Agent	Processing (ms)	254	502	1238	1997
		Communication (ms)	18	45	306	852
		Traffic (bytes)	486	1463	6852	27036
//ifType /following-sibling ::ifOutOctets	Gateway ↔ Agent	Processing (ms)	1254	2674	4852	7958
		Communication (ms)	17	46	311	850
		Traffic (bytes)	486	1471	6692	26536

Processing Time depending on XPath Expression (2)



Processing Time depending on XPath Expression (3)



Performance Evaluation Summary (1)

❖ Network Traffic

- The network traffic overhead between manager and gateway is half as much as between gateway and agents
- The total traffic volume between multiple gateways and the SNMP agents remains the same even if we add more XML/SNMP gateways
- The traffic volume between the XML-based manager and gateway increases about 2000~3000 bytes as the number of gateway increases

❖ Response Time

- One SNMP agent: the response time between the manager and gateway is 12 times as longer as the response time between the gateway and agent
- More than 80 agents: the response time between the gateway and agent consumes about 97% of the total response time between the manager and agent

Performance Evaluation Summary (2)

❖ Response Time

- One gateway
 - the total response time increases in scale by about 3000ms every time we add ten SNMP agents until the number of agents is 80
 - if the number of SNMP agents exceeds 80, the total response time sharply increases by 10000~25000ms
 - Two gateways: the entire response time is almost twice as fast as the response time of one gateway.
 - Three gateways: the entire response time is three times faster than the response time of one gateway
- ➔ 70~80 SNMP agents are suitable for one gateway to manage for the configured gateway

Performance Evaluation Summary (3)

❖ Resource Usage

- XML-based Manager

- CPU usage

- increases by 1~5% every time we add 10 SNMP agents
 - increases by 2~3% every time we add one more gateway

- Memory usage

- increases by less than 1% every time we add 10 SNMP agents
 - increases by 1~2% every time we add one more gateway

Performance Evaluation Summary (4)

❖ Resource Usage

- XML/SNMP Gateway

- CPU usage

- increases almost linearly by 5~7% until the number of SNMP agents becomes 80
 - sharply increases more than 15% after the number of SNMP agent exceeds 80
 - two gateways: decreases to half
 - three gateways: decreases to one-third

- Memory usage

- increases by 1~2% every time we add ten SNMP agents
 - decreases about 1~4% as we add one more gateway

➔ CPU usage is a more important computing resource than memory usage

Performance Evaluation Summary (5)

❖ Upgrade of Computing Resource

- XML/SNMP Gateway
 - CPU upgrade: 800MHz to 2.8 GHz
 - Memory upgrade: 256MB to 512MB

➔ Response time between the gateway and agents improves about ten times

❖ XPath Expression

- Network traffic is various depending on XPath expression
- Network traffic can be decreased as the XPath expression is complex
- However, the processing time in the gateway increases.

➔ The appropriate XPath expression must be applied considering the network traffic and processing time

Concluding Remarks

- ❖ Applied our XNMS to manage the various network devices deployed in the POSTECH campus gigabit network
- ❖ Measured the network traffic, response times and computing resources (CPU usage & Memory usage)
- ❖ Future Work
 - Need to perform a tuning process to optimize the CPU of the XML-based manager and the gateway
 - More tuning process of XPath expression in manager and gateway

Q & A



Resource Usage of XML-based Manager

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	CPU Usage(%)	5.1	5.9	6.9	8.7	11.8	16.7	21.7	23.8	25.6	27.4	30.4
	Memory Usage(%)	10.2	13.8	14.2	14.6	14.7	15.1	15.4	16.0	16.3	17.1	17.7
2	CPU Usage(%)	5.1	7.1	8.5	10.8	14	19	24.4	26.4	28	30	32.5
	Memory Usage(%)	10.2	14.8	15.1	15.5	15.8	16.1	16.6	17	17.2	18.2	18.9
3	CPU Usage(%)	5.1	8.1	10.2	12.6	16	21.3	27	29	30.3	33.3	35.7
	Memory Usage(%)	10.2	15.7	16.2	16.3	16.7	17.3	17.6	18.2	18.4	20.1	20.4

(Unit: %)

Resource Usage of XML/SNMP Gateway

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	CPU Usage(%)	3.1	8.2	10.3	14.6	22	29.1	37.5	43.8	50.4	66.3	79.5
	Memory Usage(%)	12.1	12.3	12.3	12.4	14.4	14.8	15.4	16.8	17.3	18.8	19.7
2	CPU Usage(%)	3.1	5.6	8.4	9.6	10.3	12.1	14.6	19.1	22	27.4	34
	Memory Usage(%)	12.1	12.1	12.3	12.3	12.3	12.4	12.4	13.1	14.1	14.7	15.1
3	CPU Usage(%)	3.1	5.9	6.4	7.2	7.5	8	9.7	10.3	13.2	14.7	17.5
	Memory Usage(%)	12.1	12.1	12.2	12.3	12.3	12.3	12.3	12.3	12.4	12.4	12.4

(Unit: %)

Resource Usage depending on Computing Resource

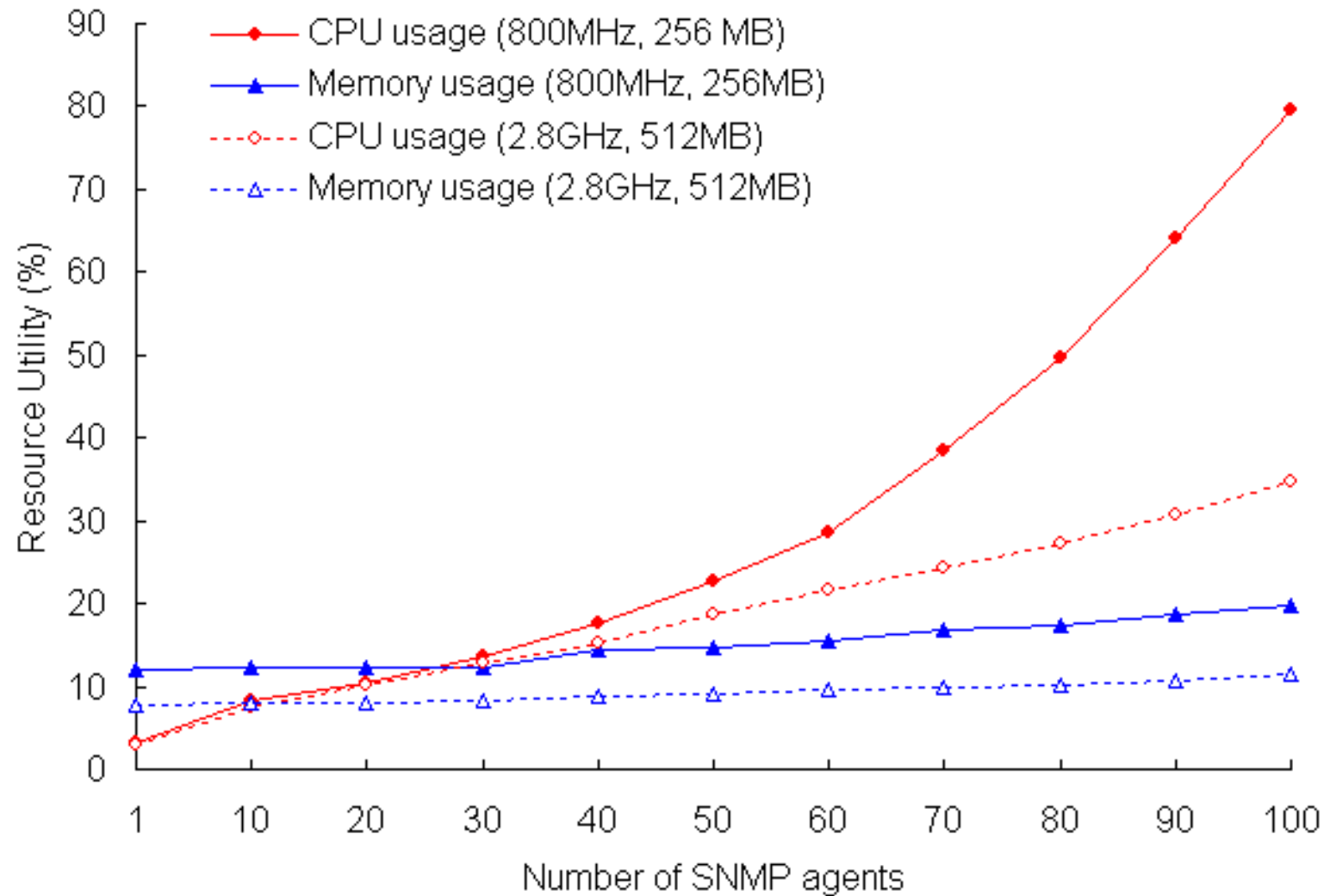
# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1 (CPU 800MHz, 256MB)	CPU Usage(%)	3.1	8.2	10.3	13.6	17.5	22.8	28.6	38.5	49.8	64.2	79.5
	Memory Usage(%)	12.1	12.3	12.3	12.4	14.4	14.8	15.4	16.8	17.3	18.8	19.7

< Resource Usage of CPU 800MHz, 256MB > (Unit: %)

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1 (CPU 2.8GHz, 512MB)	CPU Usage(%)	2.9	7.6	10.1	12.7	15.2	18.8	21.6	24.3	27.2	30.8	34.6
	Memory Usage(%)	7.8	8.0	8.1	8.3	8.7	9.0	9.5	9.8	10.2	10.7	11.4

< Resource Usage of CPU 2.8GHz, 512MB > (Unit: %)

Resource Usage depending on Computing Resource



Performance of ifOutOctets in Interface Group

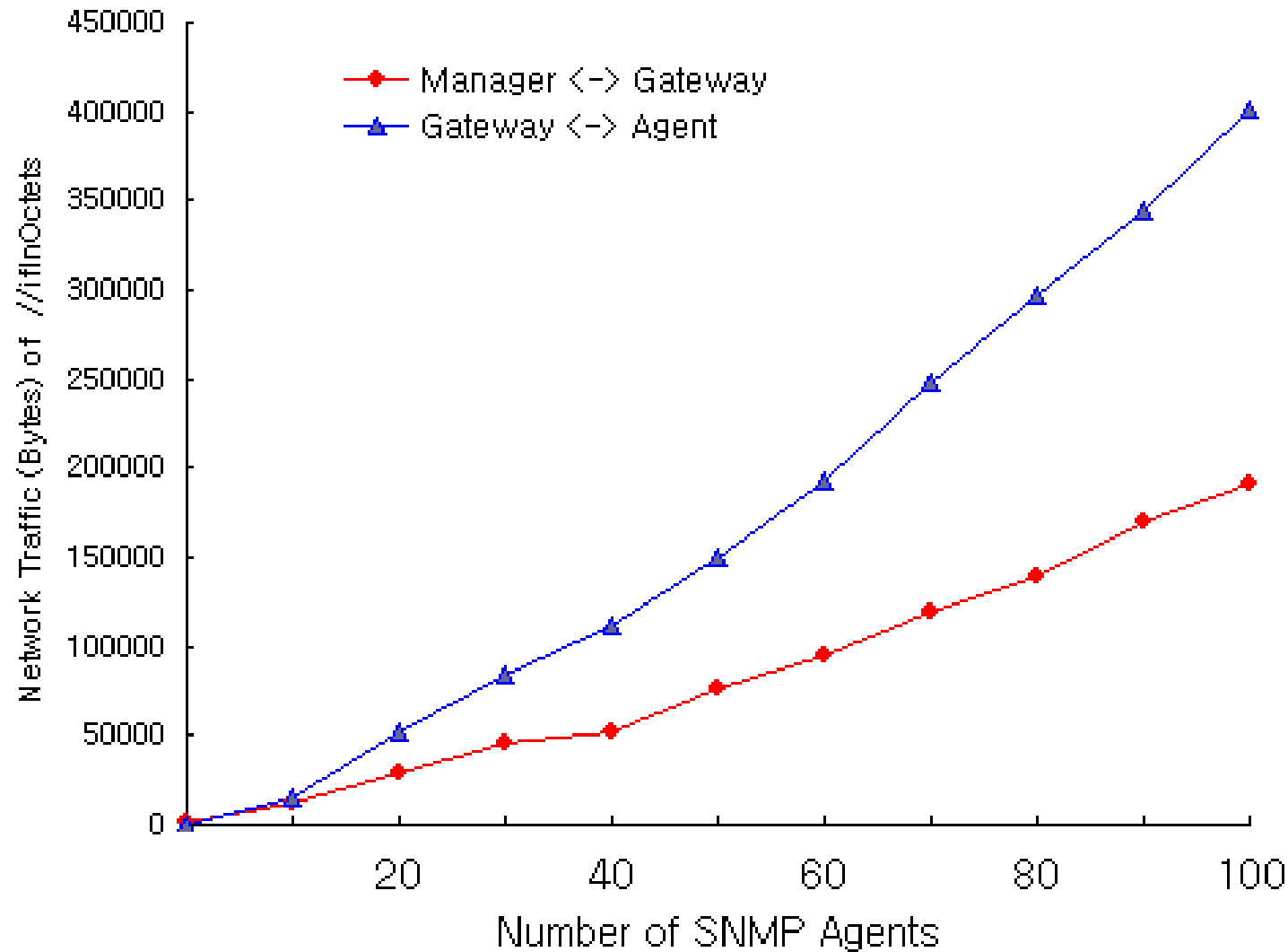
# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	Manager ↔ Gateway	1222	12075	28752	46328	52785	76540	94329	118790	138754	169743	191265
	Gateway ↔ Agent	684	15034	51524	83953	112038	150734	19267	248322	296532	344068	401637

< Network Traffic of ifOutOctets in Interface Group > (Unit: %)

# of Gateways	# of SNMP Agents	1	10	20	30	40	50	60	70	80	90	100
1	Manager ↔ Gateway	289	389	478	612	785	896	1176	1378	1612	1865	2305
	Gateway ↔ Agent	268	3069	11085	28047	40078	64368	82085	99047	120125	154035	201264
	Total	557	3458	11563	28659	40863	65264	83261	100425	121737	155900	203569

< Response time of ifOutOctets in Interface Group > (Unit: %)

Network Traffic of ifOutOctets in Interface Group



Response Time of ifOutOctets in Interface Group

