

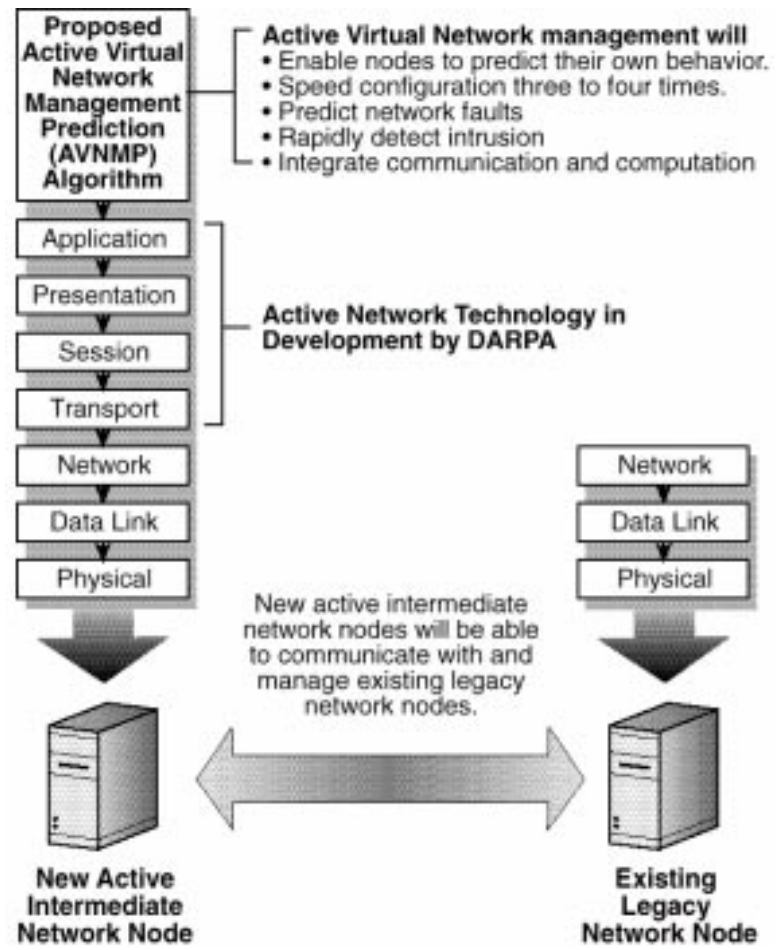
ACTIVE VIRTUAL NETWORK MANAGEMENT  
PROTOCOL

*STEPHEN F BUSH*

October 20, 1998

GOAL

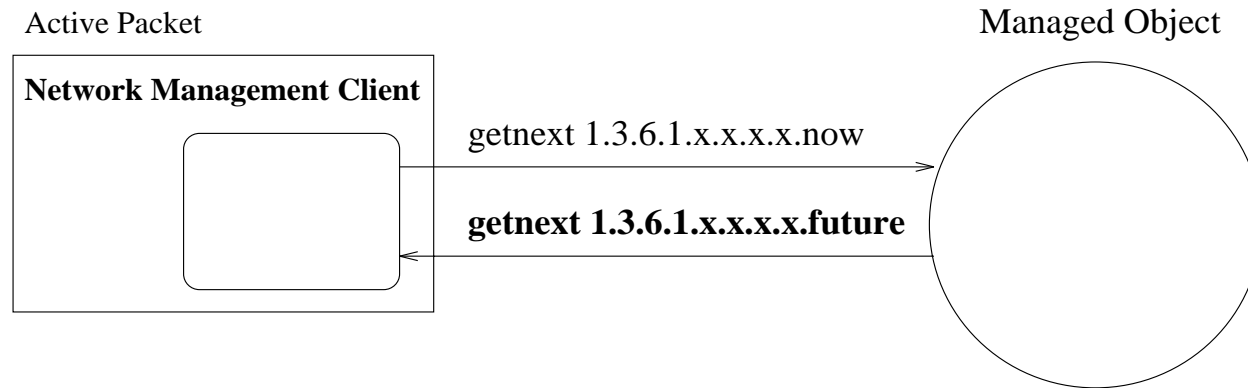
# What are Active Networks?



# Active Virtual Network Management Protocol (AVNMP)

## Self-Prediction

Communication networks capable of predicting their behavior.



## AVNMP Applications

### **Mobility**

GPS location prediction

### **Information Warfare**

Insecurity path prediction

### **Predictive QoS**

Service predictable enough that applications can acceptably operate.

ARCHITECTURE

## Background Information

### Couple Optimistic Discrete Event Simulation with Active Networking

- A form of self-adjusting Time Warp is used.
- Network devices represent themselves as Logical Processes (LP).
- LPs process virtual messages ASAP.
- Rollback is used to adjust for out-of-order or out-of-tolerance predictions.
- LPs and Virtual Messages (VM) are implemented as active packets.
- VMs have a future timestamp.

# Streptichron

$\overbrace{\text{Strepti}}^{\text{bend}} \overbrace{\text{chron}}^{\text{time}}$  is an active packet facilitating prediction.

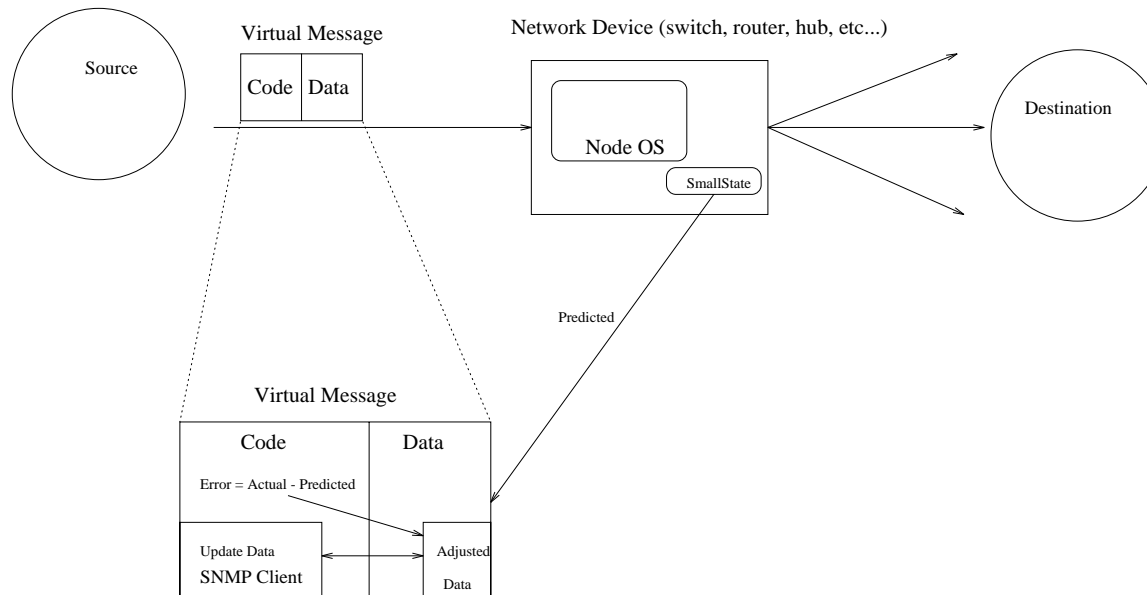
Streptichrons are generated by driving processes.

Streptichron  $\triangleq$  { Executable Input Model (Monte-Carlo) Load Model  
Model Parameters (Self Adjusting)  
Virtual Message (Self Adjusting) Location Prediction

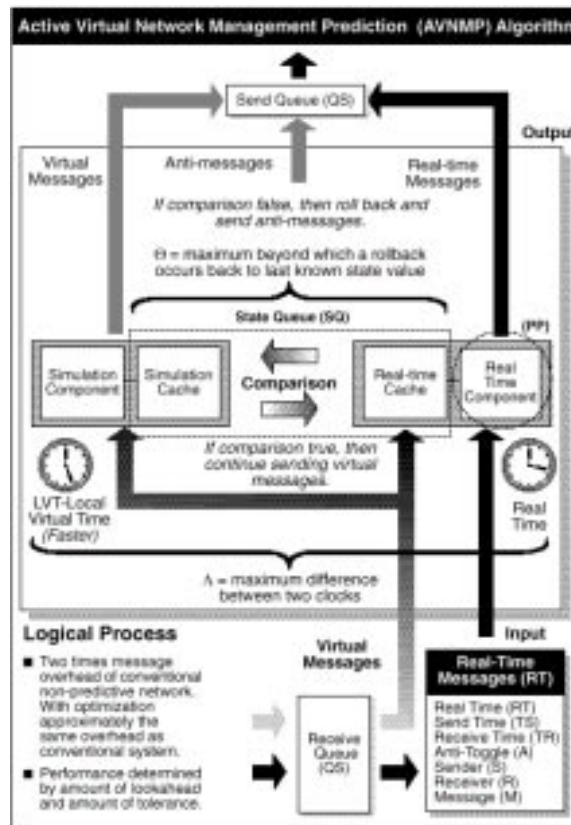
# Autoanaplasis

*self adjusting*  
Auto anaplasis is the self-adjusting characteristic of streptichrons.

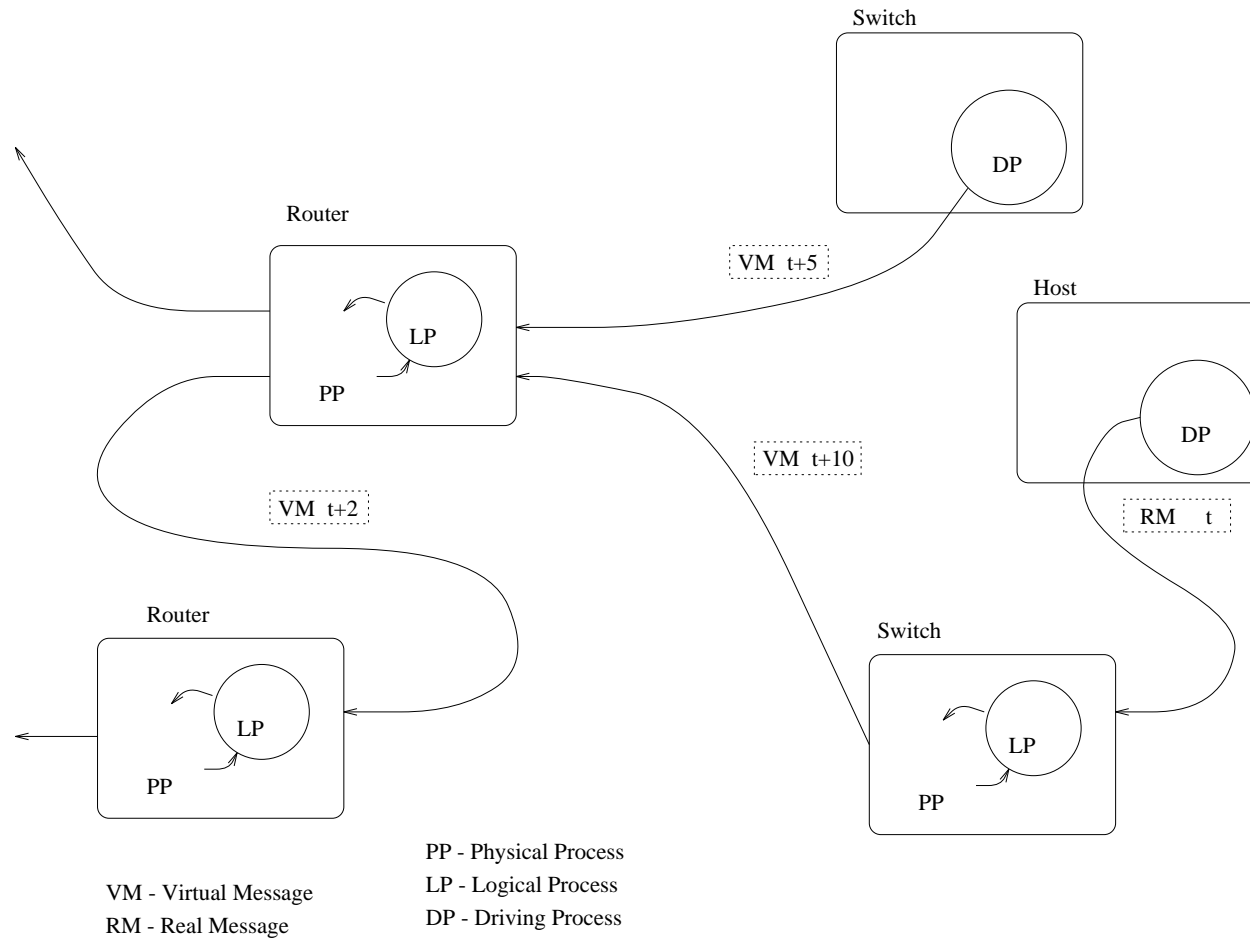
Example: For load prediction, use transit time to check prior predictions.



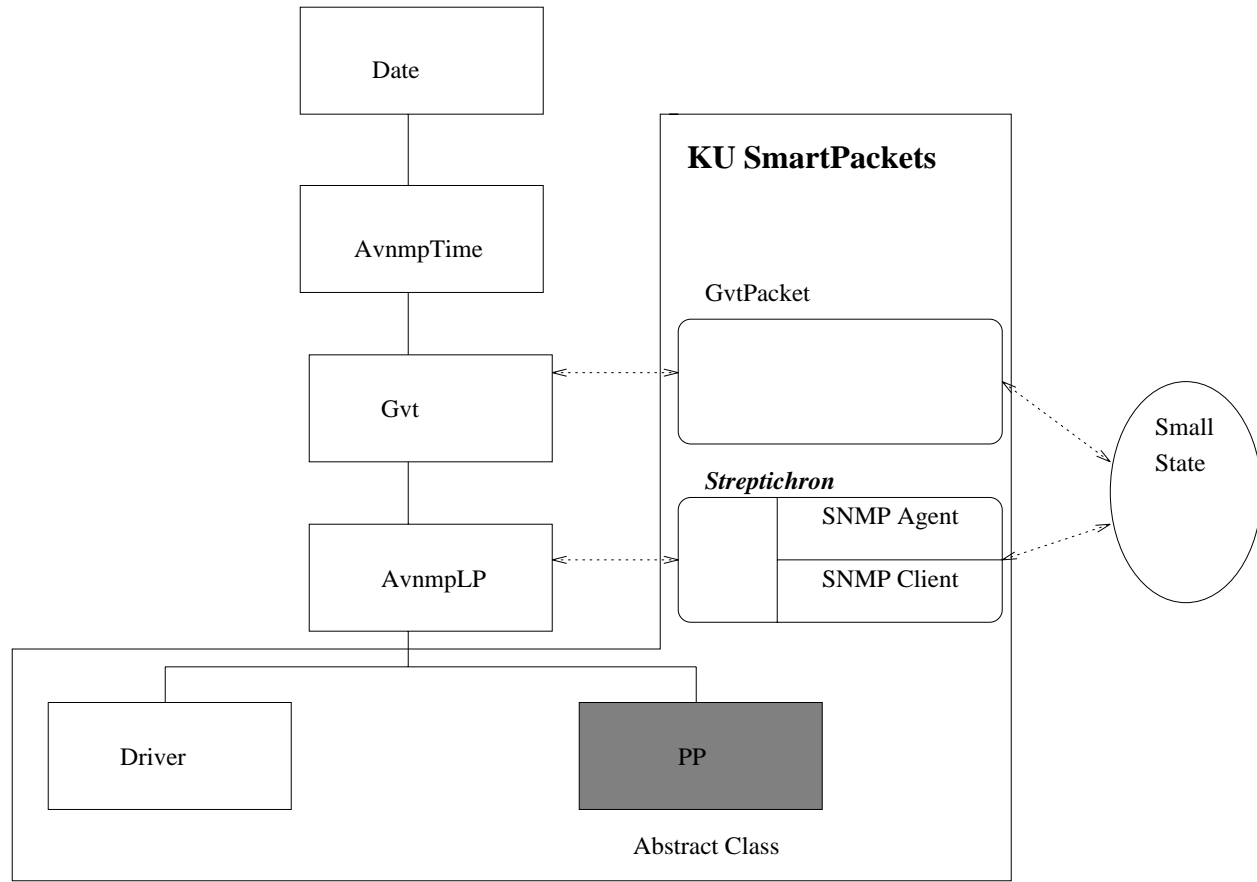
# Logical Process



# AVNMP Architecture

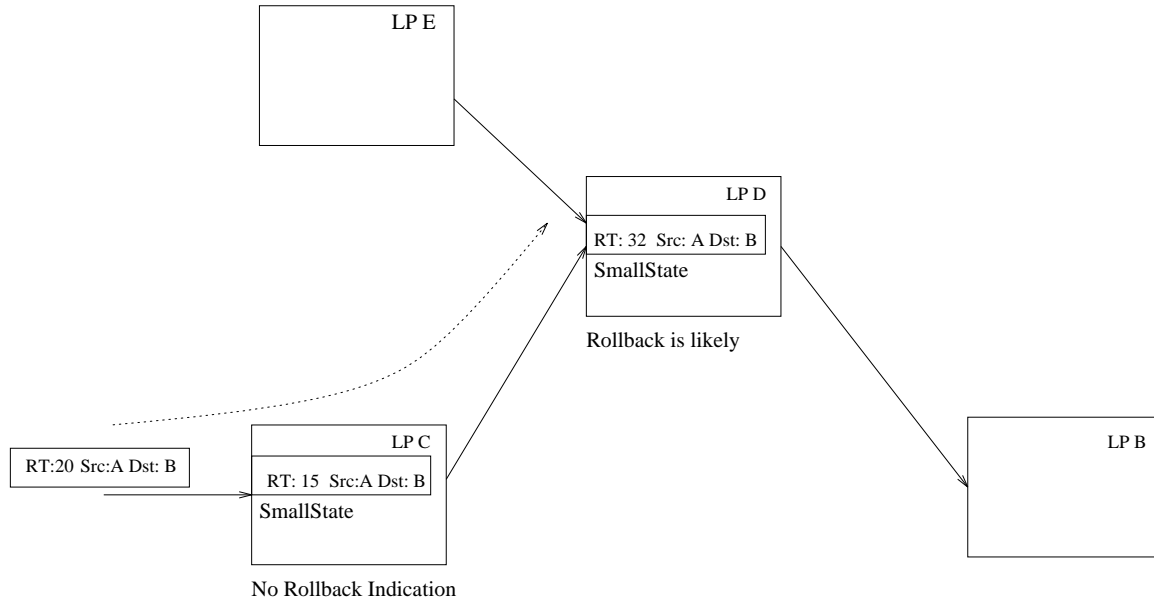


# AVNMP Class Hierarchy



# Virtual Message Fusion

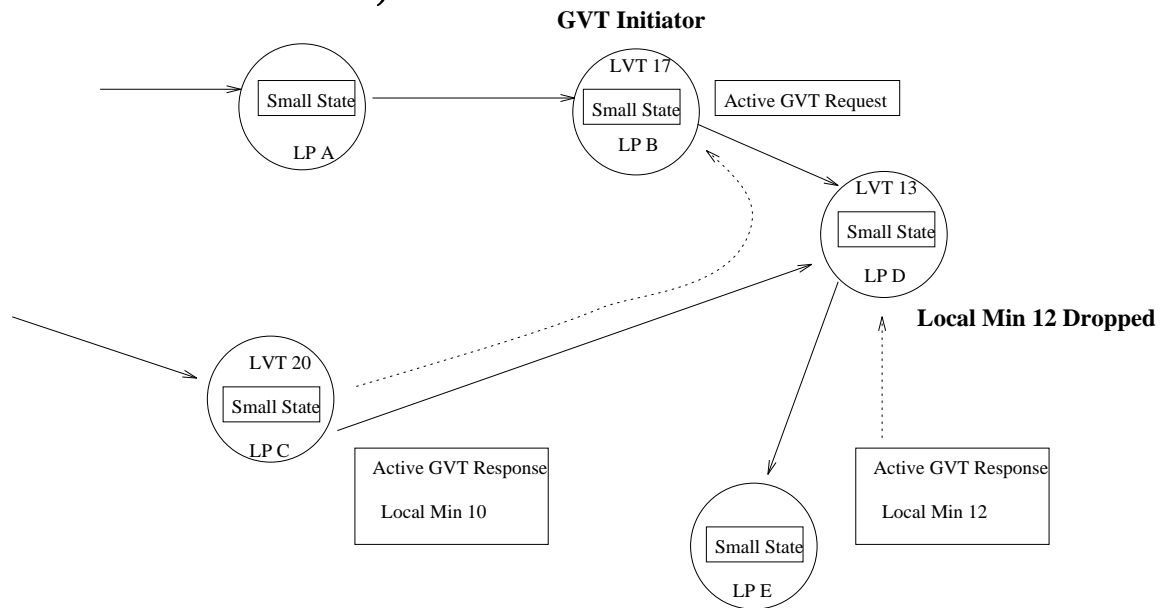
Potential rollback can be detected early.



RT - Receive Time  
LP - Logical Process

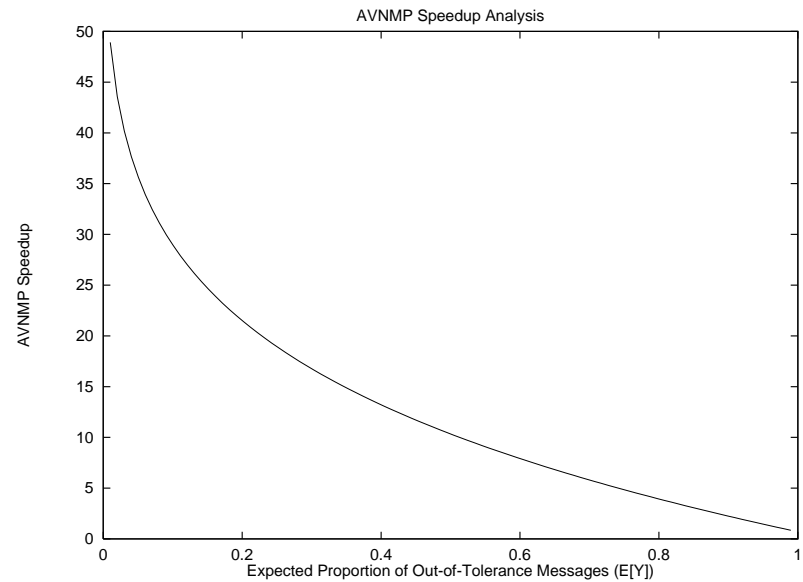
# Active GVT Calculation

$\left. \begin{array}{l} \text{Local Min} > \text{Cached\_value} \\ \text{Local Min} > \text{LVT} \end{array} \right\} \rightarrow \text{GVT Response dropped}$



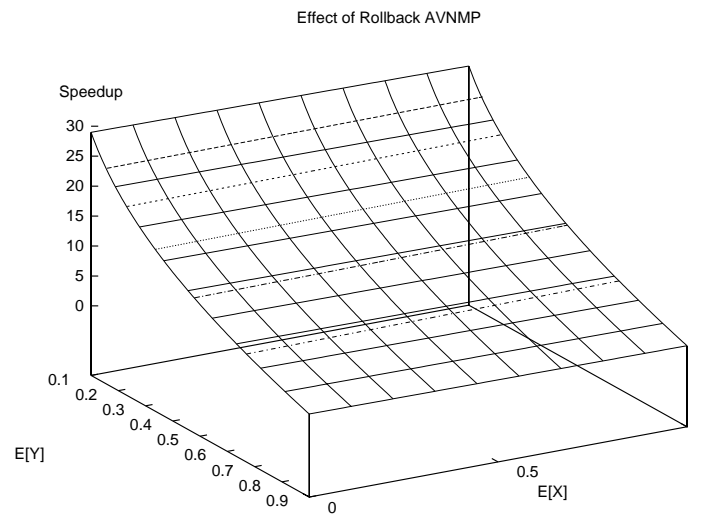
EXPECTED RESULTS

# AVNMP Speedup



- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\Delta_{vm} = 30.0$  milliseconds
- $\tau_{task} = 7.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

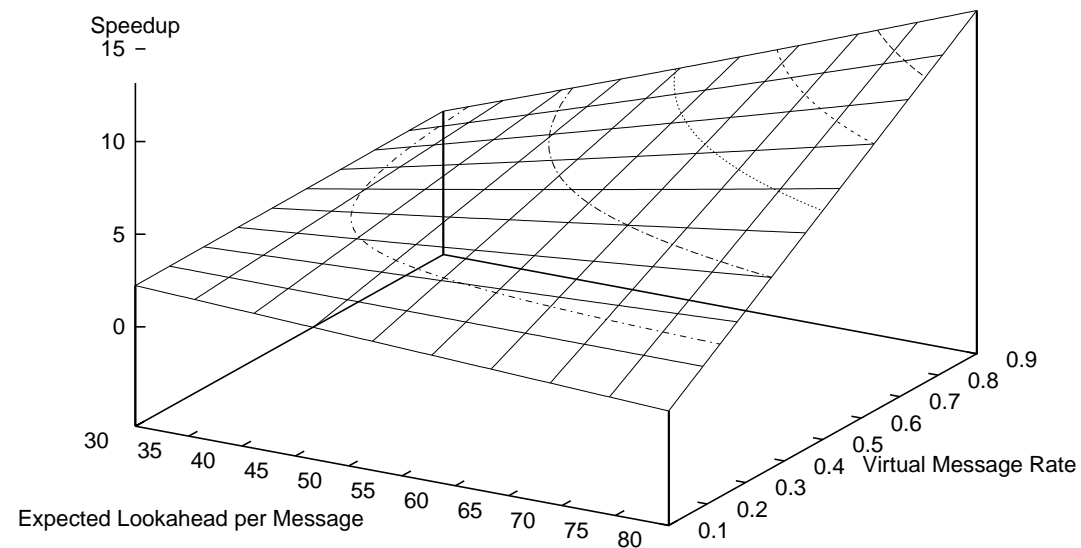
## Effect of Rollback on AVNMP



- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\Delta_{vm} = 30.0$  milliseconds
- $\tau_{task} = 7.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

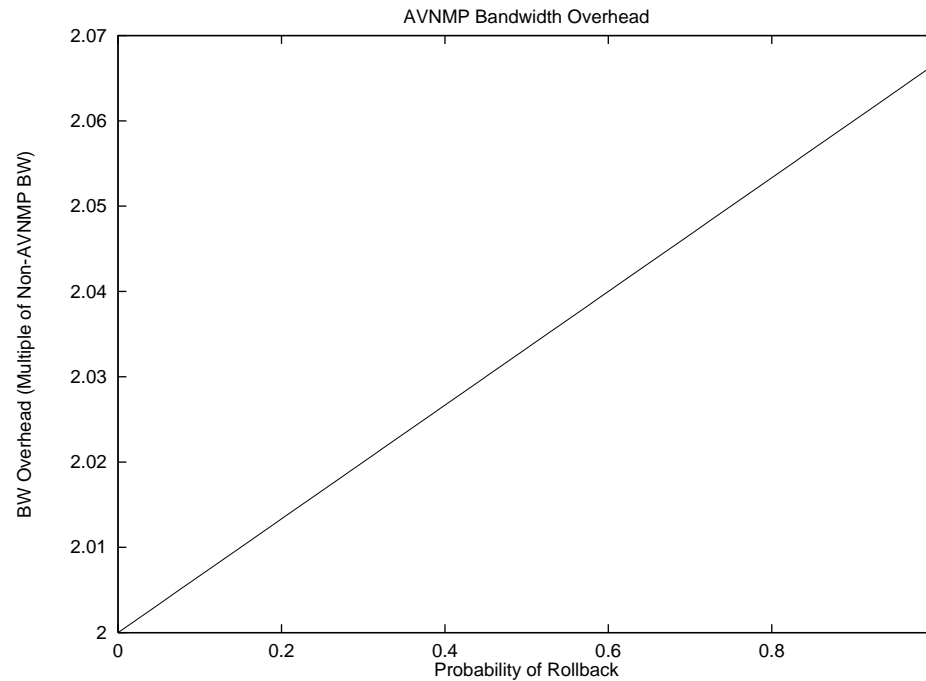
## Virtual Message Rate

Effect of Virtual Message Timing on AVNMP



- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\tau_{task} = 7.0$  milliseconds
- $\Delta_{vm} = 30.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

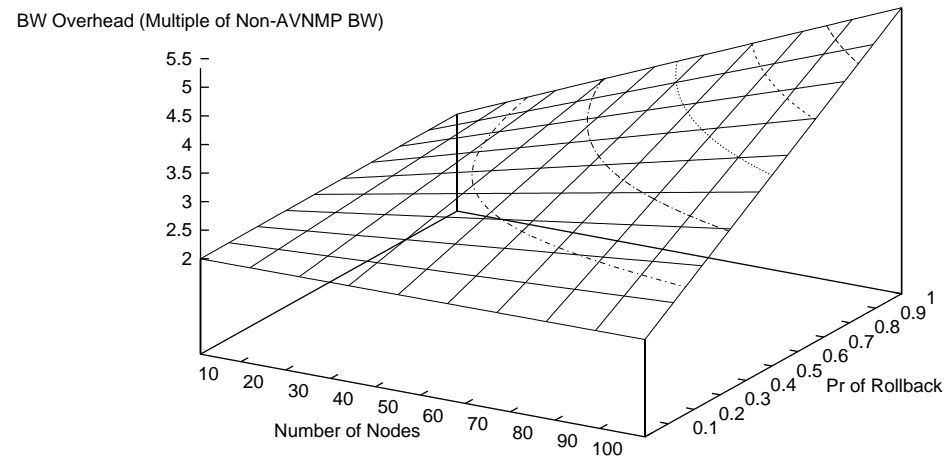
# Bandwidth Overhead



- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\Delta_{vm} = 30.0$  milliseconds
- $\tau_{task} = 7.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

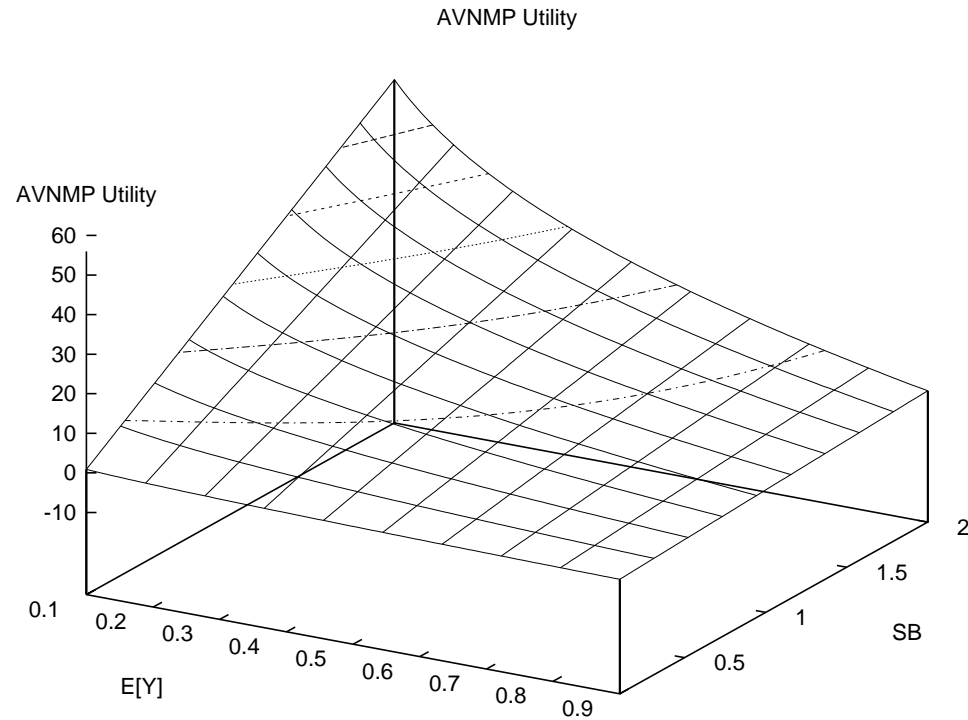
# AVNMP Scalability

AVNMP Scalability



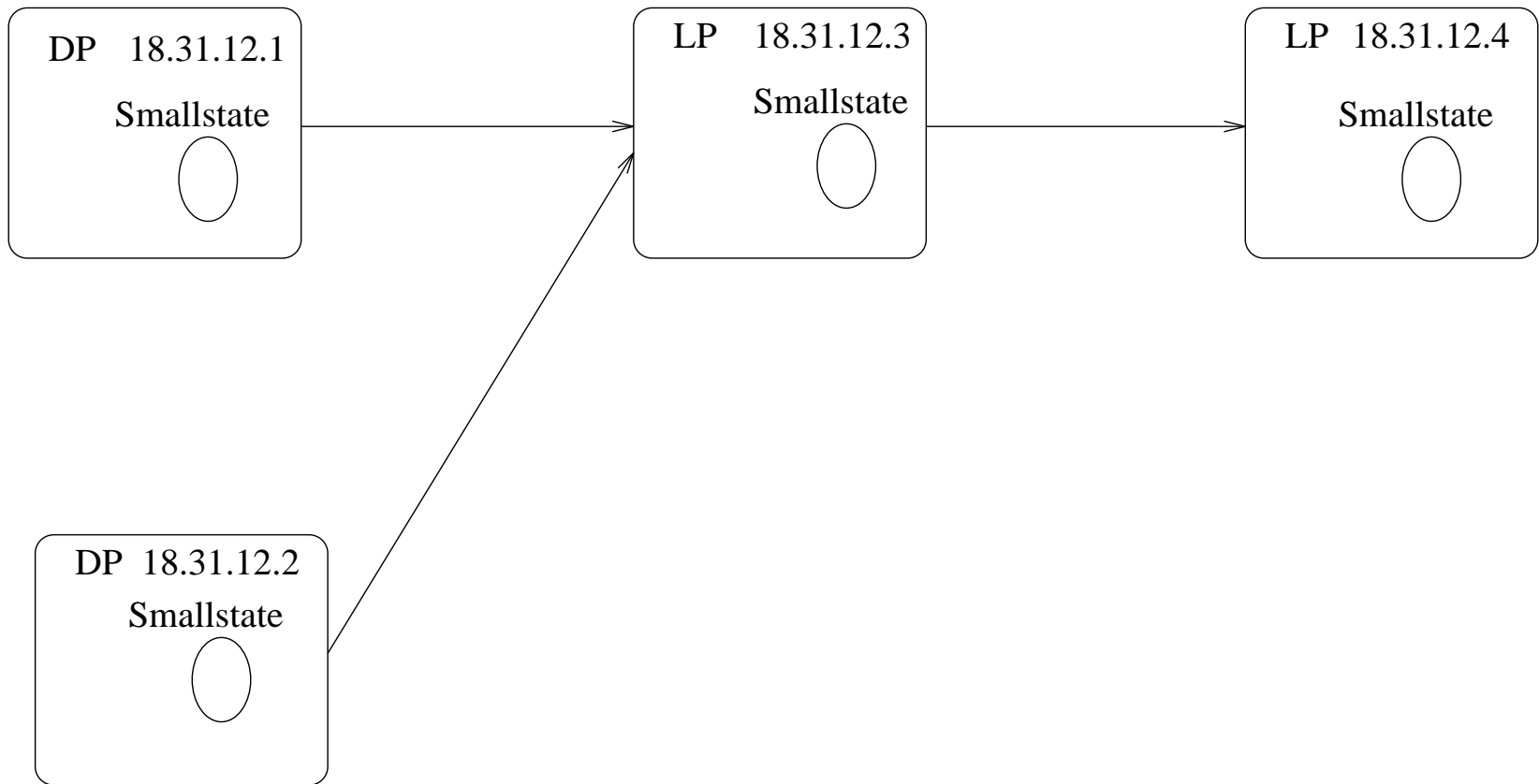
- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\Delta_{vm} = 30.0$  milliseconds
- $\tau_{task} = 7.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

## AVNMP Utility Graph



- $\lambda_{vm} = 0.03$  virtual messages per millisecond
- $\Delta_{vm} = 30.0$  milliseconds
- $SB =$  (Relative utility of speed over bandwidth)
- $\tau_{task} = 7.0$  milliseconds
- $\tau_{rb} = 1.0$  milliseconds
- $C_r = 3.5$

# Demo Topology

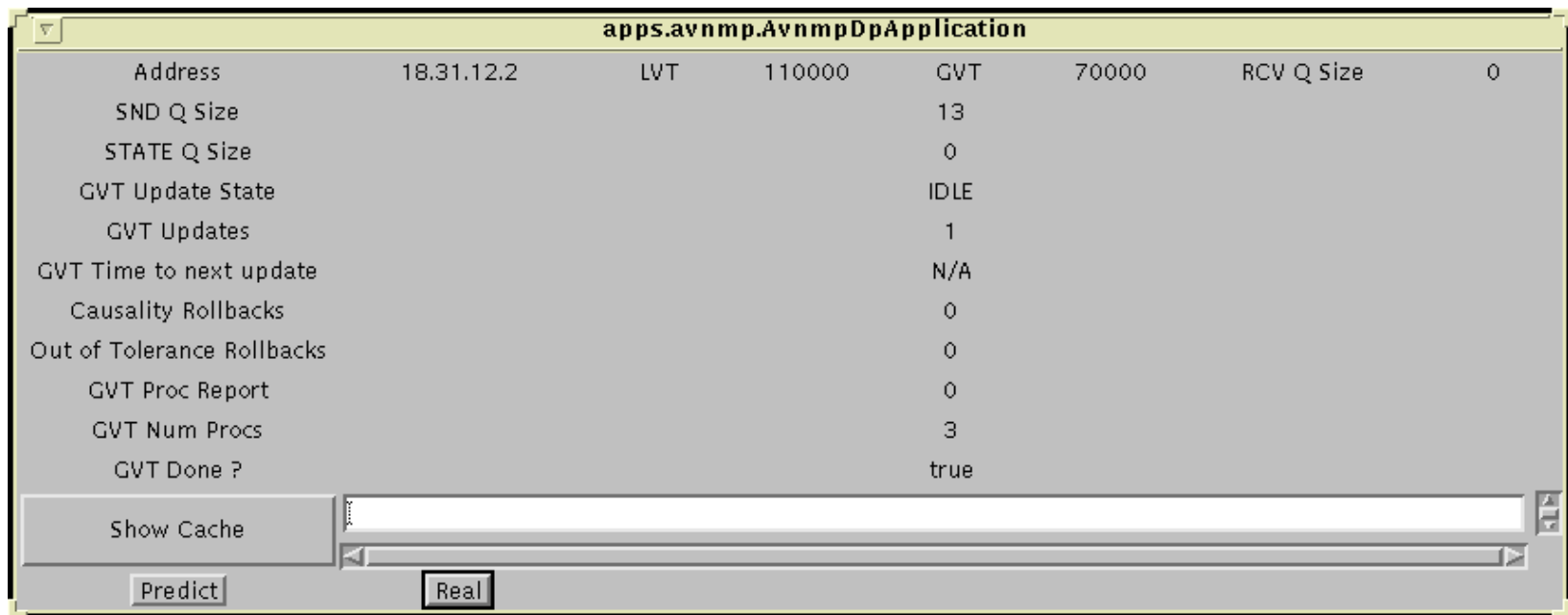


**apps.avnmp.AvnmpDpApplication**

Address	18.31.12.1	LVT	110000	GVT	70000	RCV Q Size	0
SND Q Size				14			
STATE Q Size				0			
GVT Update State				IDLE			
GVT Updates				1			
GVT Time to next update				N/A			
Causality Rollbacks				0			
Out of Tolerance Rollbacks				0			
GVT Proc Repor				0			
GVT Num Procs				3			
GVT Done ?				true			

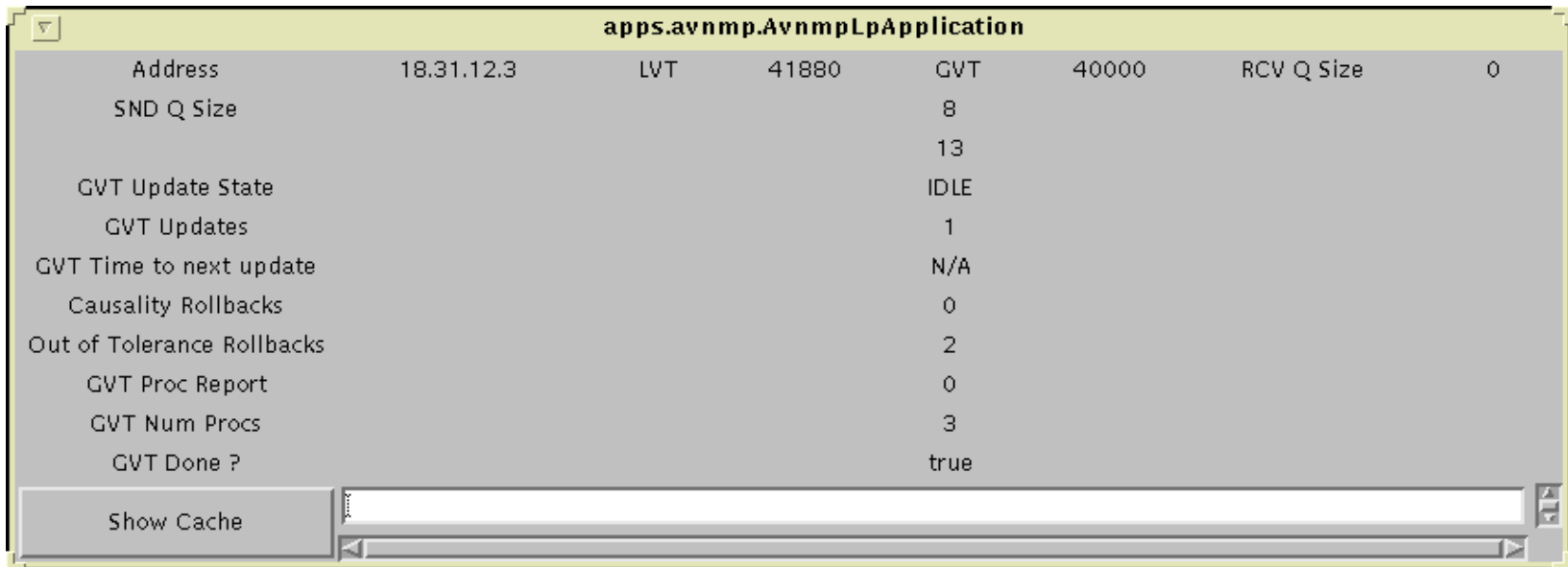
Show Cache    pdate Response Source: 18.31.12.1 Receive Time: 70000 Destination: 18.31.12.3 Send Time: 0 Payload: 0

Predict    Real



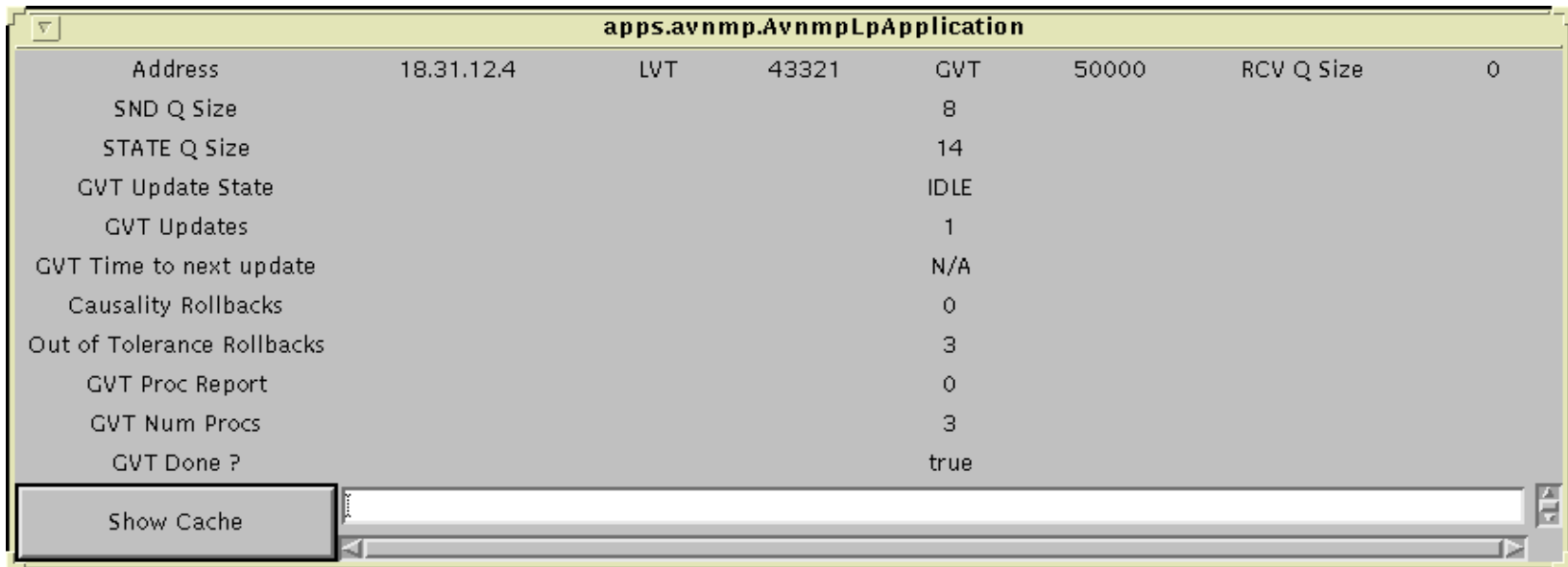
apps.avnmp.AvnmpDpApplication							
Address	18.31.12.2	LVT	110000	GVT	70000	RCV Q Size	0
SND Q Size				13			
STATE Q Size				0			
GVT Update State				IDLE			
GVT Updates				1			
GVT Time to next update				N/A			
Causality Rollbacks				0			
Out of Tolerance Rollbacks				0			
GVT Proc Report				0			
GVT Num Procs				3			
GVT Done ?				true			

Below the table, there is a 'Show Cache' button and a scrollable text area. At the bottom of the window, there are two buttons: 'Predict' and 'Real'.



The screenshot shows a terminal window with the title 'apps.avnmp.AvnmpLpApplication'. The window displays a list of network-related parameters and their values. At the bottom of the window, there is a 'Show Cache' button and a scroll bar.

Address	18.31.12.3	LVT	41880	GVT	40000	RCV Q Size	0
SND Q Size				8			
				13			
GVT Update State				IDLE			
GVT Updates				1			
GVT Time to next update				N/A			
Causality Rollbacks				0			
Out of Tolerance Rollbacks				2			
GVT Proc Report				0			
GVT Num Procs				3			
GVT Done ?				true			



The screenshot shows a window titled "apps.avnmp.AvnmpLpApplication" with a list of parameters and their values. A "Show Cache" button is visible at the bottom left of the window.

Parameter	Value
Address	18.31.12.4
LVT	43321
GVT	50000
RCV Q Size	0
SND Q Size	8
STATE Q Size	14
GVT Update State	IDLE
GVT Updates	1
GVT Time to next update	N/A
Causality Rollbacks	0
Out of Tolerance Rollbacks	3
GVT Proc Report	0
GVT Num Procs	3
GVT Done ?	true

# SUMMARY

## Summary

- AVNMP Architecture
- Streptichron
- Expected Results
- Effectively coupling Optimistic Discrete Event Simulation with Active Networks
  - Active GVT Calculation
  - Virtual Message Fusion
  - Autoanaplasia
- Developed generic working proto-type
- Developed MIB and incorporated SNMP management

## On-Going Work

- Dynamic Message Reprioritization
- Specific Application of AVNMP (Current code is generic)
- Examine properties and impact of predictive algorithms upon AVNMP
- Dynamic and automatic deployment of AVNMP LPs