Implementing IPv6 for Windows NT

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Main Points

- Windows NT is a good base
  for network protocol development
- Our release is great sample code:
  http://research.microsoft.com/msripv6

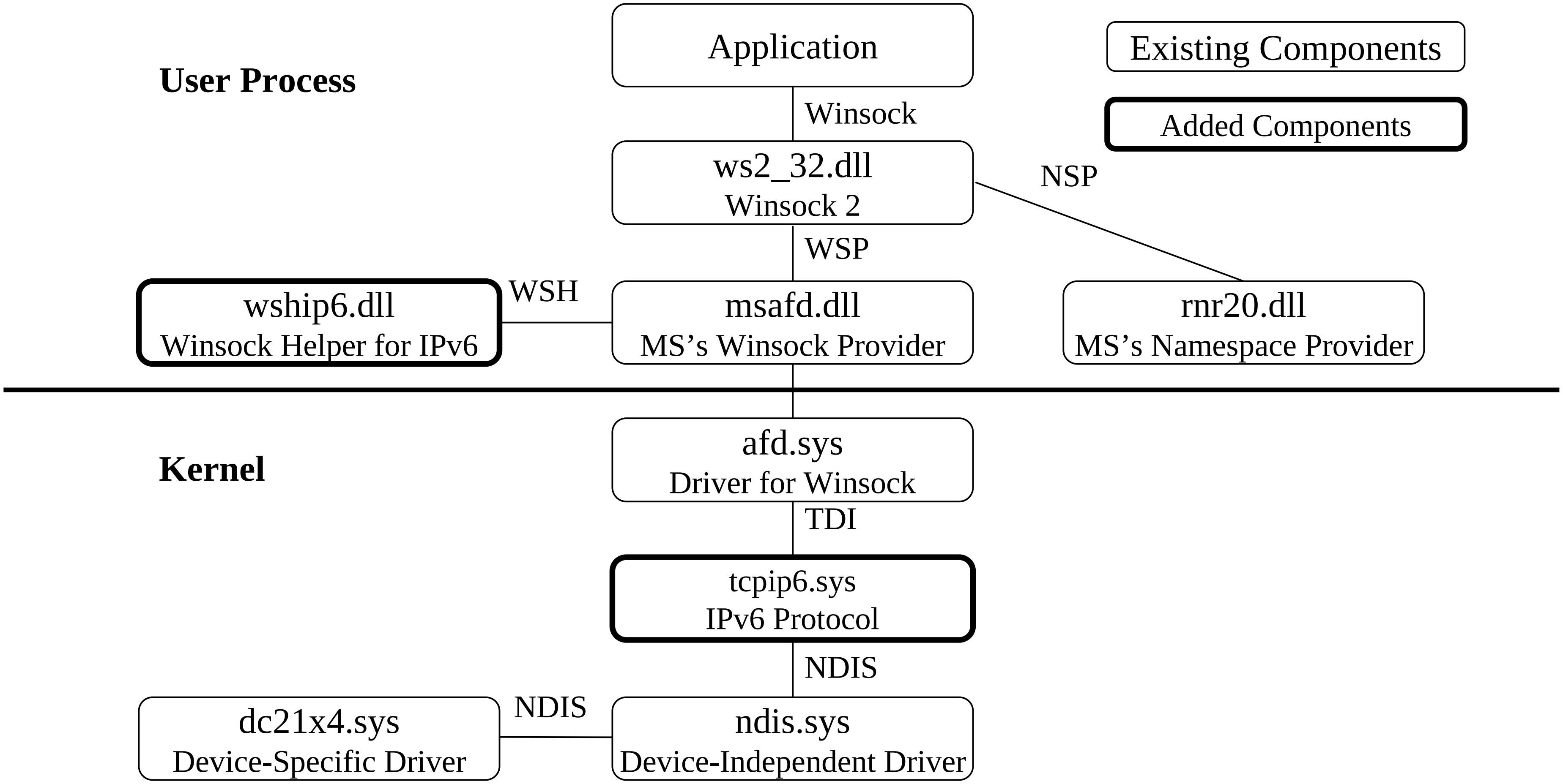
Outline

- Motivation
- Windows NT Networking
- Our Implementation
- Problems & Solutions
- Source Code Access
- Performance
- Conclusions

Motivation

- Primarily a learning experience
- Bootstrap Microsoft on IPv6
- Platform for further research

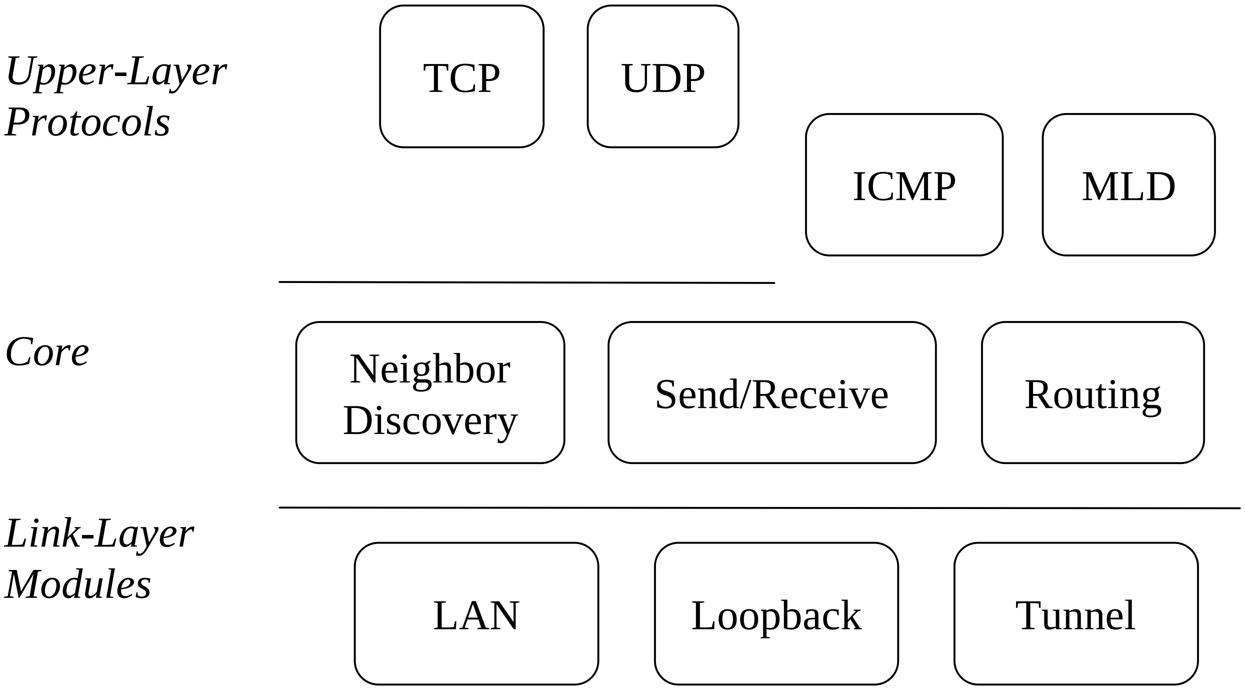
Windows NT Networking



Our Implementation

- Started with NT 4.0 TCP/IP source code
- Supports only IPv6
- Supports only NT 4.0/5.0

Our Implementation



Upper-Layer Protocols

TCP

UDP

ICMP

MLD

Core

Neighbor Discovery

Send/Receive

Routing

Link-Layer Modules

LAN

Loopback

Tunnel

Problems & Solutions

- NDIS receive handlers
- Adding link-layer headers
- “Pull-up” non-contiguous packet data
- Preventing deadlock with NDIS and TDI

NDIS Receive Handlers

- Asynchronous callbacks
- ProtocolReceive
  - flat look-ahead buffer
  - may need separate call to transfer data
- ProtocolReceivePacket
  - NDIS_PACKET structure with buffer chain
  - not implemented by all NICs
  - miniport owns the packet/buffers

NIC Implementations

- ProtocolReceive + transfer data
  - Intel EtherExpress 16
- ProtocolReceive
  - SMS EtherPower II
  - 3com Fast Etherlink XL
  - Intel EtherExpress PRO
- ProtocolReceivePacket
  - Digital DE435

Our NDIS Receive Handler

- Link-layer module hides complexity
  - Pass up our own IPv6_PACKET structure
- Supports both receive handlers
  - IPv4 code only supported ProtocolReceive
- Does transfer-data internally if needed
  - May introduce a copy relative to IPv4

Adding Link-Layer Headers

- Must construct link-layer header before handing packet to NDIS
- NT 4.0 IPv4 code chains a buffer in the link-layer module
  - Adds complexity
  - Reduces performance
- Allocate space up front
  - But how much space?
  - NDIS does not support a packet offset

Our Solution

- Leave room for worse-case link-level header
- Rewrite NDIS packet to hide unused space
  - Must undo this after the send completes
  - Communicate offset value in the context area
  - What if the unused space spans two pages?

Source Code Access

- Source for Windows NT 4.0 TCP/IP
  - Sample code, UDP/TCP, TDI glue
  - Replaced all link-layer, IP, ICMP, MLD code
  - DDK sample code
- Source for other Windows NT components
  - Not essential
  - Useful for debugging & documentation
  - Our only modification was a fix in msafd.dll

Performance

TCP Throughput in KB/s

	10 Mb/s	100 Mb/s
IPv4	1058±4	10995±20
IPv6	1032±3	10790±30

- Expected 1.4% slower, saw 2.5% / 1.9%
- 300Mhz P-II -> 266Mhz, SMC Etherpower II

Conclusions

- Windows NT is a good base for network protocol development
- Our release is great sample code: http://research.microsoft.com/msripv6
  - Testing, research, educational uses