Some Technical Aspects of Internet

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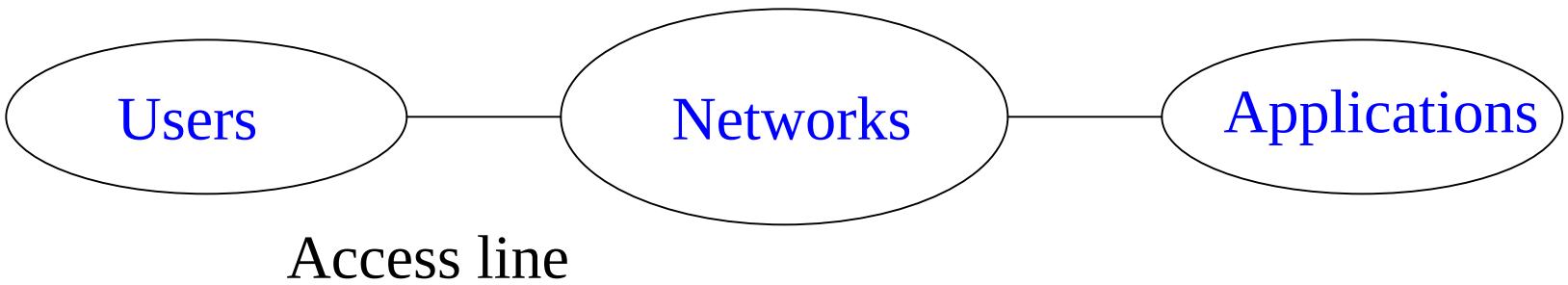
International Telecommunication Union

Outline

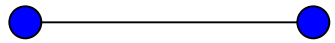
- Networks and standards
- Layers and transport modes
- Intelligence and routing
- Other aspects, in particular name resolution
- Policy issues

Networks (1/3)

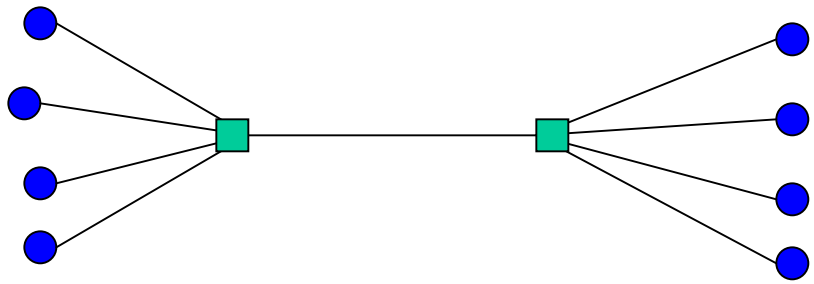


Networks (2/3)

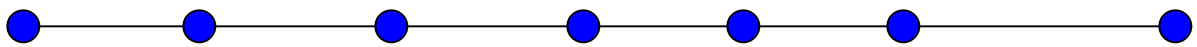
Point to point



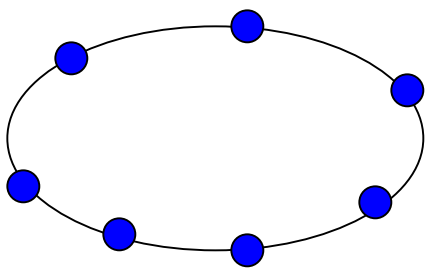
Multiplexing



Bus



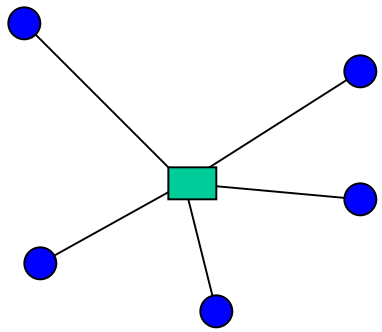
Ring



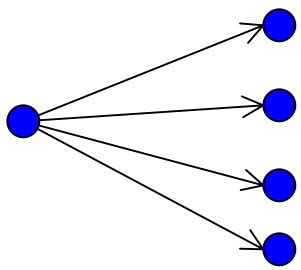
Not all topologies can be used with all technologies

Networks (3/3)

Hub and spoke



Broadcast



Not all topologies can be used with all technologies

Standards and ITU-T positioning

Intergovernment

ITU-T

Task Force

IETF

NGOs

ISO,IEC,
IEEE, ETSI, ECMA
TTC, Committee T1,
ARIB, TIA, SCTE

Forums & Consortia

1394TA	3GPP	3GPP2	AIM	AMF	AMI-C
AOEMA	AOW	ATMF	BINTERMS	Bluetooth	Cable Modems
CBOP	CDG	CIF	CII	CommerceNet	CommerceNet J
COS	CTFJ	DHF	DISA	DOPG	DSLF
ECE	ECHONET	ECOM	ECTF	EDIFICE	EEMA
EIDX	EMA	EMF	ERTICO	EWOS	FCIA
FCIA-J	FIPA	FRF	FSAN	GSM Assoc.	HNF
Home API	HomePNA	HRFWG	IDB Forum	IFIP	IFSA
IMTC	IMWA	IrDA	ITS America	ITS UK	JAVA
JCTEA	JECALS	JEDIC	JEMA	JICSAP	JIMM
JMF	LONMARK	MCPC	MDG.org	MITF	MMCF
Mobile Web	MOPA	MPLSF	MSForum	MWIF	OASIS
ODVA	OIF	OMG	OSGi	PCCA	PCISIG
PCMCIA	PHS MoU	PICMG	POF	Salutation	SCF
SDR	SSIPG	STA	TINA-C	TMForum	TOG
TSC	UMTS	USBIF	UWCC	W3C	WAP
WDF	Web 3D	WfMC	WIN Forum	WLIF	XTP Forum

How does ITU-T Develop Recommendations?

- Consensus of Sector Members and Member States
- Work typically driven by Sector Members
- Open (for members), transparent, bottoms-up process
- Sensitive to national sovereignty: will only cover matters not considered to be national
- Will not impose contractual terms or operating rules on private companies

Recommendations are not binding, but tend to be followed because they represent a true consensus.

What is ITU's Situation (1/2)

- ITU-T is a dynamic, well-respected industry-government partnership (650 Sector Members)
- Examples of ITU-T Recommendations:
  - G.723.1 & G.729 - Speech coding for Voice over IP and other applications
  - H.323 - Packet based multimedia communication systems - the protocols behind Voice over IP, along with:
    - H.245 - Control protocol for multimedia communications
    - H.248 - Gateway control protocol (developed jointly with IETF)
  - X.509 - Public-key encryption
  - V.90 - 56kbit/s PSTN modems - providing ubiquitous worldwide internet access
  - G.99x series - xDSL Recommendations for broadband access

What is ITU's Situation (1/2)

TSB

ITU-T Approval and publication times

	before 1988	1989-1993	1993-1996	1997-2000	2001-2004
Approval time	**4 years**	**2 years**	**18 months**	**9 months** (exceptional case: **5 months**)	**2-9 months**
Publication time	**2-4 years**	**2 years**	**1-1.5 year**	**6-12 months**	**3-9 months**

Notes:

1. **Pre-published Recommendations, available on ITU-T Website, from a few days to four weeks after approval of the text.**
2. **Recs in force, pre-published, superseded/obsolete: available on ITU-T Website.**
3. **Forms of publication: paper, CD-ROM, electronic bookshop, online, etc.**
4. **FREE ONLINE ACCESS SINCE JANUARY 2001 (one free access per member, 3 free downloads for public)**
5. **"Approval time" counted between "determination/consent" and final approval**

Majority of Recommendations approved in less than 2 months

Layers (simplified)

- ADSL, ISDN, Cable modem, modem (ITU, forums)
  - Last mile
- ATM, Fiber, etc (ITU, forums)
  - backbone
- TCP/IP (IETF)
  - Transport
- SMTP (IETF)
  - Application (E-Mail)
- HTTP/HTML (W3C)
  - Application (WWW)

See http://www.itu.int/osg/spu/ip/index.phtml

Transport modes

- Connection-oriented circuit switched
  - Telephone (ITU)
- Connection-oriented packet switched
  - Data communication, e.g X.25 (ITU, others)
- Connectionless packet switched
  - TCP/IP (IETF, ITU, others)

MPLS overlays connection-oriented on connectionless

Intelligence

- None until circa 1965 (advent of small computers)
- Then question: where to put the intelligence?
  - Only in center (at hubs): SS7
  - Only at edges (at terminals): Internet

Neither model is pure:
GSM has considerable intelligence in terminals
Internet has centralized DNS, proxies, routing, …

Routing

- Static for most networks
  - Manual reconfiguration if problems
- Dynamic for Internet
  - Robust, self-correcting

End-to-end

- All networks are end to end
- But in Internet, corollary of intelligence at edge is for center to do nothing except pass information unchanged end to end
  - RFC 3869:"global addressability of hosts, end-to-end transparency of packet forwarding".
- This ideal is not always achieved:
  - Firewalls
  - Network address translation (NAT)
  - Dynamic IP address allocation
  - proxies

Firewalls are needed whenever the edges cannot be trusted, which is **always** in public networks

Tarifs

- Traditionally depended on:
  - Size of message/time used to transmit
  - Distance
  - Crossing national boundaries
- Not the case, in general, for Internet
- Half-line costs and interconnect issues (ITU-T Study Group 3)

What are Names and Addresses

ITU distinguishes names and address. Some relevant ITU definitions are:

- **Name**: A combination of characters and is used to identify end users (E.191).
- **Address**: A string or combination of digits and symbols which identifies the specific termination points of a connection and is used for routing (E.191).

Naming and addressing

Internet

- Domain name
- IP Address
- DNS
- Root servers

Telephony (fixed or mobile)

- Telephone number
- SANC/IMSI
- SS7
- No equivalent

For a brief summary, with references to more details,
see PP 02 Information Document 6 at:
http://www.itu.int/md/meetingdoc.asp?type=sitems&lang=e&parent=S02-PP-INF-0006

Name allocation

- Traditionally done:
  - By ITU at international level
  - By national authority at national level
- For Internet:
  - Since 1998, by ICANN at international level
  - By ccTLD operators at national level
- Some historical issues persist

Address allocation

- Traditionally done:
  - By ITU at international level
  - By national authority at national level
- For Internet:
  - By Regional Internet Registries at international level
  - By Internet Service Providers at national level
- Historical imbalance in IPv4 address allocation

Mapping Names to Addresses

Internet	Telephony (fixed or mobile)
DNS	SS7
• Logically hierarchical WW	➢ Logically hierarchical WW
• Physically hierarchical WW	➢ Physical hierarchy depends on network operators
• Single authoritative operational root	➢ No single authoritative operational root

DNS Name Resolution

- *Name resolution* is the process by which resolvers and name servers cooperate to find data in the name space
- To find information anywhere in the name space, a name server only needs the names and IP addresses of the name servers for the root zone (the “root name servers”)
  - The root name servers know about the top-level zones and can tell name servers whom to contact for all TLDs

DNS Name Resolution

- A DNS query has three parameters:
  - A domain name (e.g., `www.nominum.com`),
    - Remember, every node has a domain name!
  - A class (e.g., *IN*), and
  - A type (e.g., *A*)
- A name server receiving a query from a resolver looks for the answer in its authoritative data and its cache
  - If the server isn't authoritative for the answer and the answer isn't in the cache, the answer must be looked up

DNS Resolution Process

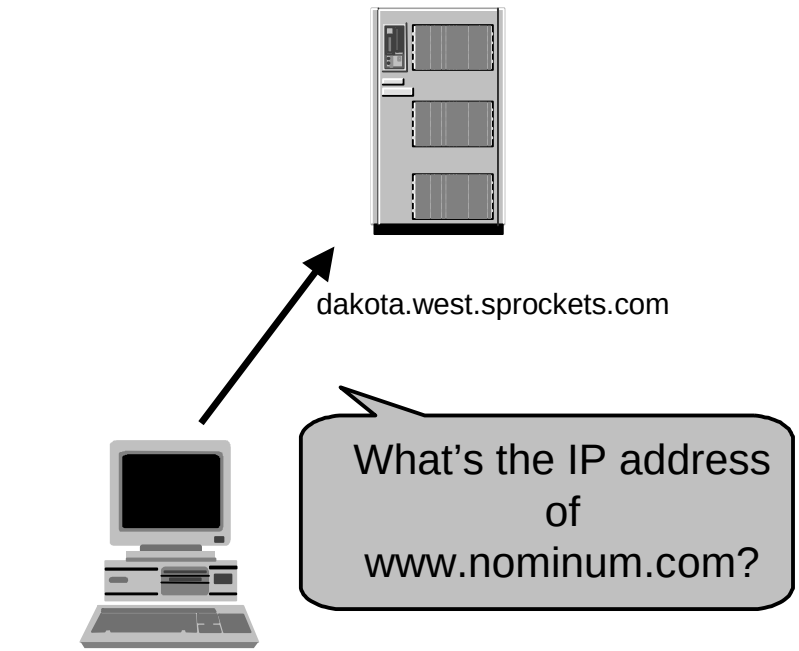
- Let’s look at the resolution process step-by-step:

annie.west.sprockets.com

```
ping www.nominum.com.
```

DNS Resolution Process

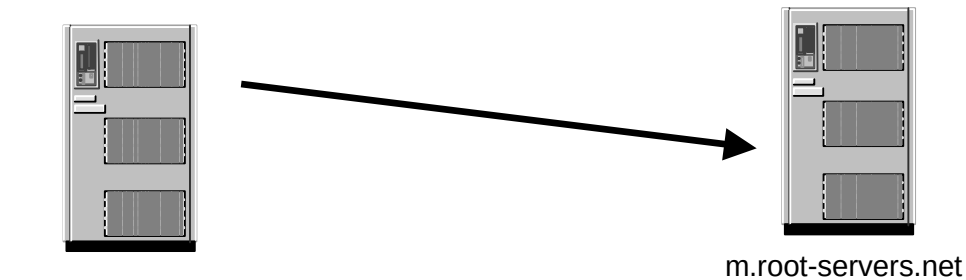
- The workstation *annie* asks its configured name server, *dakota*, for *www.nominum.com's* address




```
ping www.nominum.com.
```

DNS Resolution Process

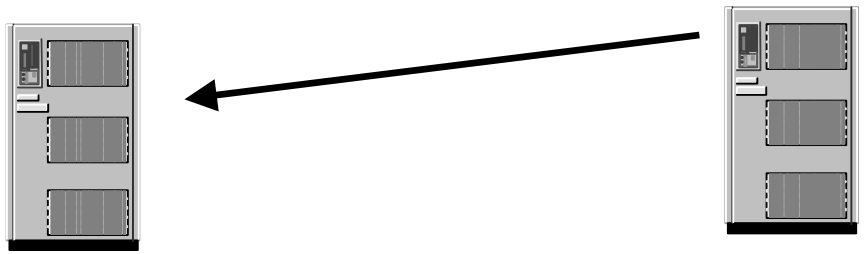
- The name server *dakota* asks a root name server, *m*, for *www.nominum.com's* address




```
ping www.nominum.com.
```

DNS Resolution Process

- The root server *m* refers *dakota* to the *com* name servers
- This type of response is called a “referral”

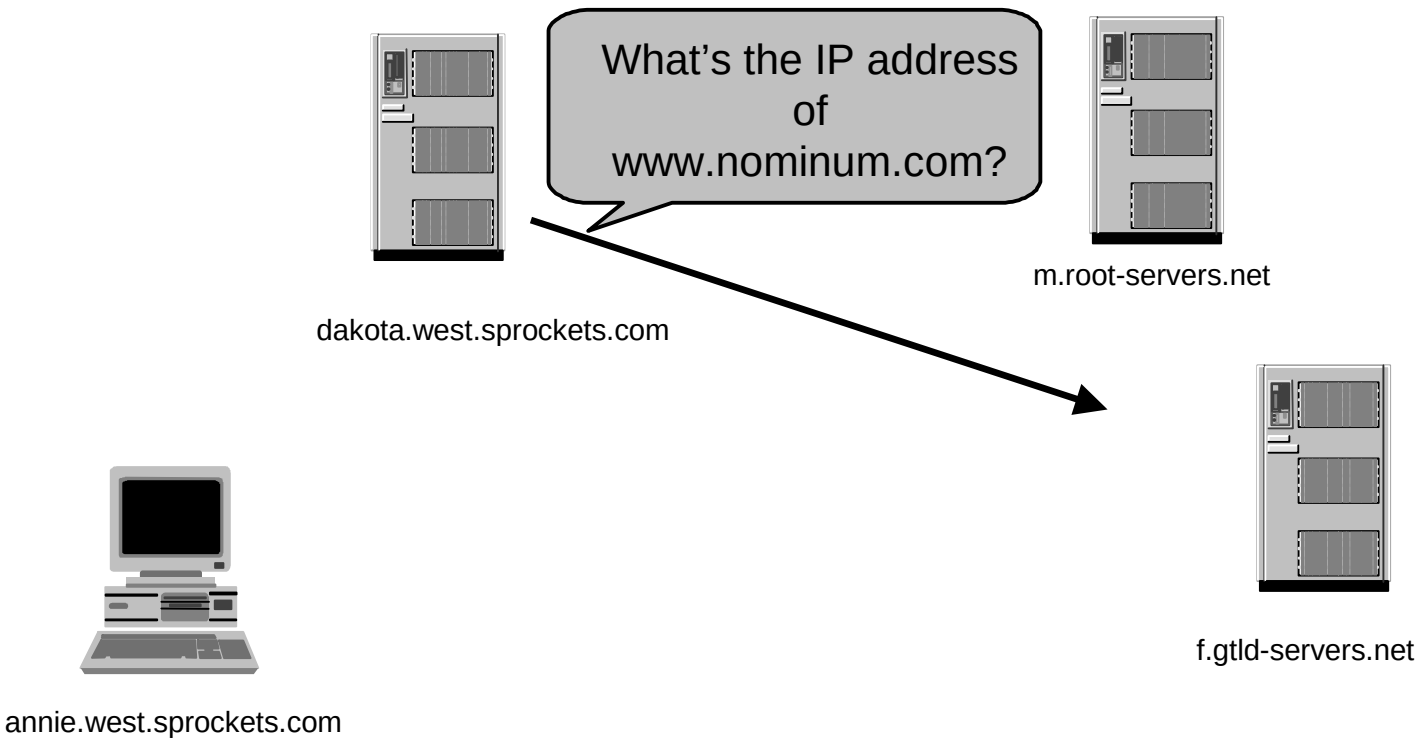


annie.west.sprockets.com

```
ping www.nominum.com.
```

DNS Resolution Process

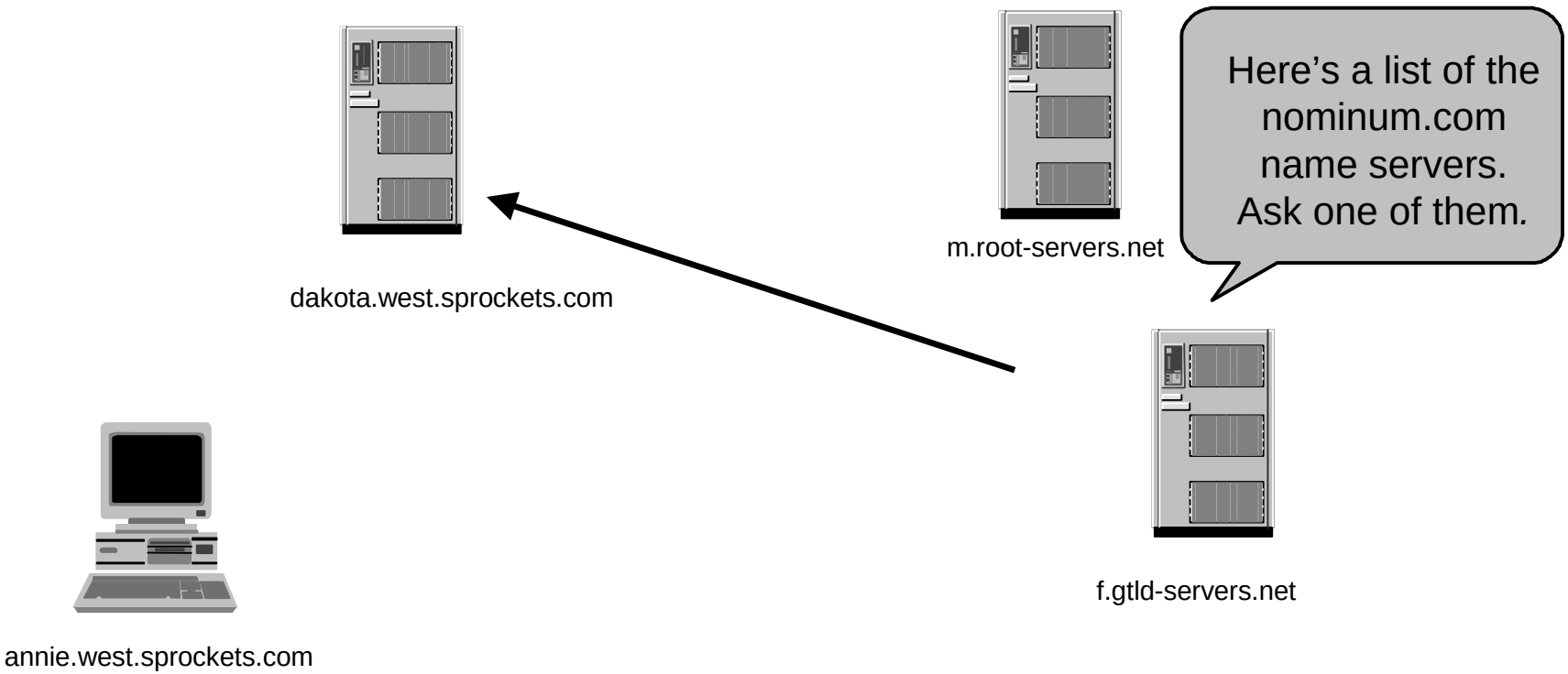
- The name server *dakota* asks a *com* name server, *f*, for *www.nominum.com's* address




```
ping www.nominum.com.
```

DNS Resolution Process

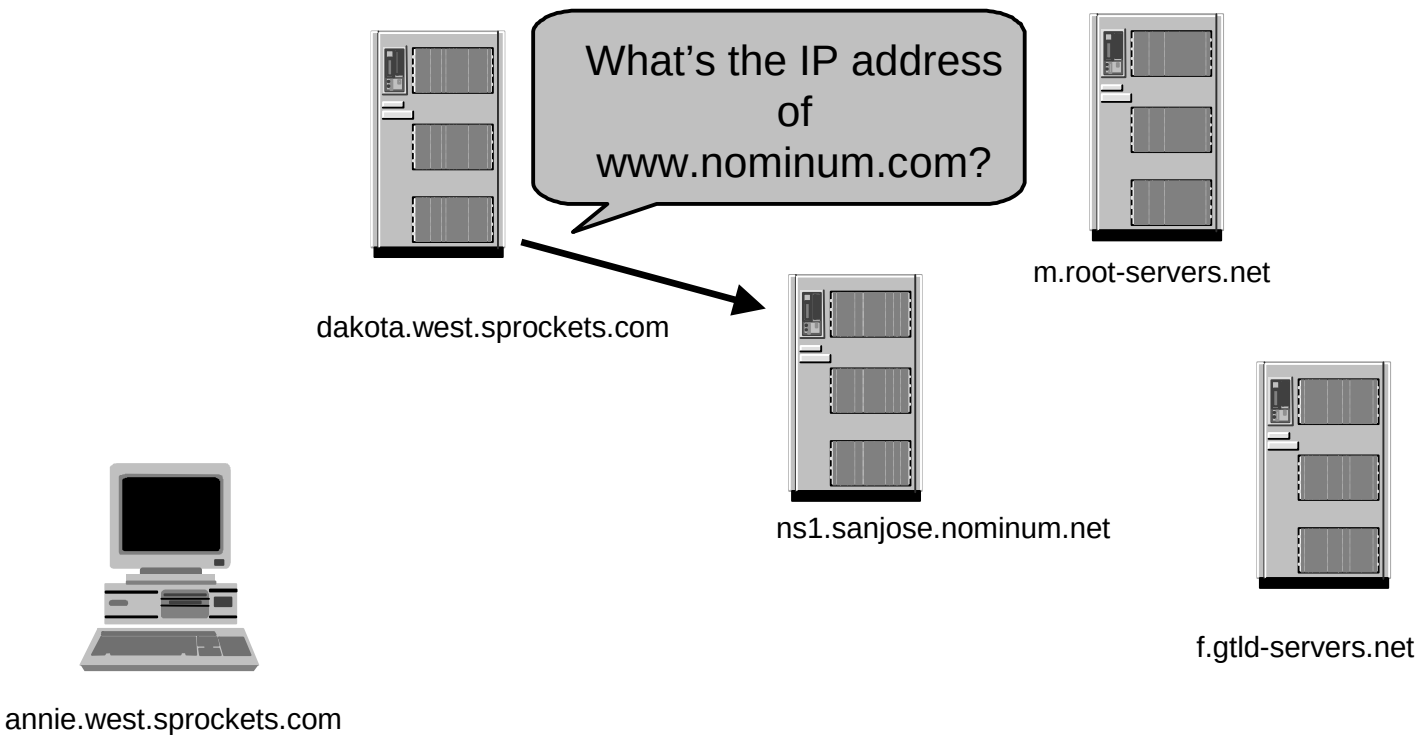
- The *com* name server *f* refers *dakota* to the *nominum.com* name servers




```
ping www.nominum.com.
```

DNS Resolution Process

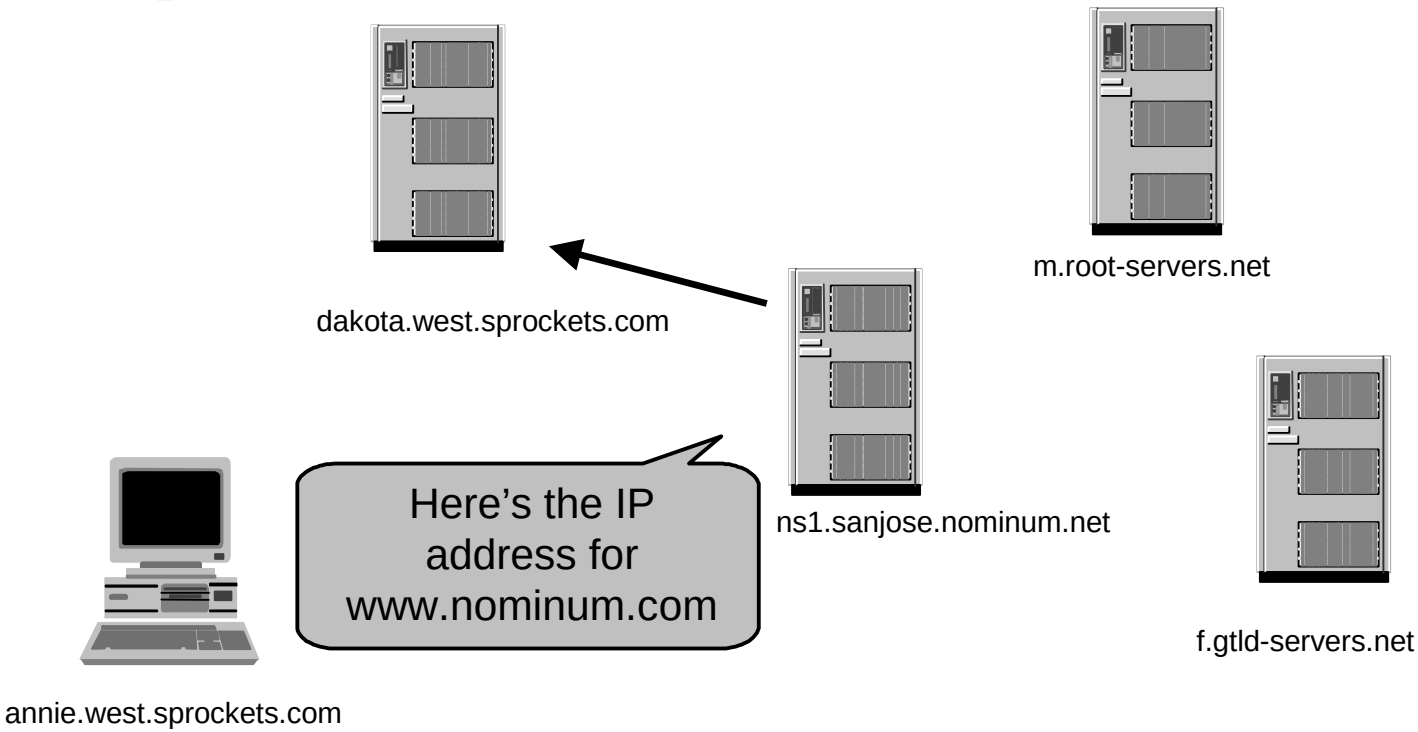
- The name server *dakota* asks an *nominum.com* name server, *ns1.sanjose*, for *www.nominum.com's* address




```
ping www.nominum.com.
```

DNS Resolution Process

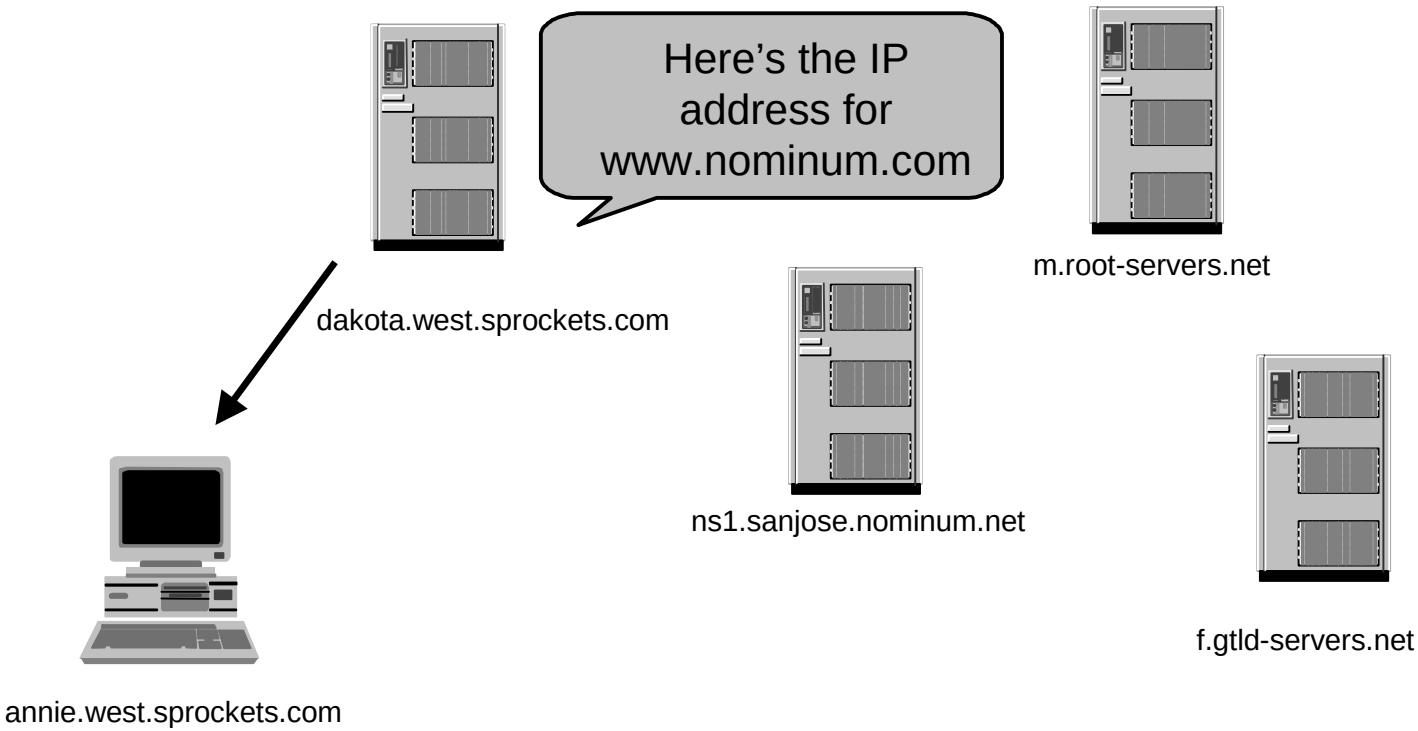
- The *nominum.com* name server *ns1.sanjose* responds with *www.nominum.com's* address




```
ping www.nominum.com.
```

DNS Resolution Process

- The name server *dakota* responds to *annie* with *www.nominum.com's* address




```
ping www.nominum.com.
```

SS7 Resolution process

- Conceptually similar in principle
  - Volume larger (circa 2B devices, vs 700M)
- Details differ
  - SS7 can transmit many types of messages, including text (SMS)
- Top-level servers not necessarily synchronized
- Each operator makes arrangements to access some SS7 provider

Security Basics

Ref: E.408, X.800, X.805

TSB

Threats	Services	Techniques
Loss of service	Availability	Many
Disclosure of information	Confidentiality	Encryption
Unauthorized access	Authentication	PKI (X.509) Known content
Fraud	Integrity	PKI, Notary
	Confirmation of delivery	Return message
…	…	…

For more information: http://www.itu.int/itudoc/itu-t/85097.html

Security Hot Issues

- Telephone number misuse
  - Rogue dialers
- SPAM (see http://www.itu.int/osg/spu/spam/index.phtml)
  - E-Mail is not authenticated
  - Cost to send is very low
- Denial of Internet service
  - Packets are not authenticated
  - Cost to send is very low
- Viruses, worms
  - Not authenticated
  - No integrity

Policy issues (1/4)

Generic issue	Example for roads
• Universal access	➢ 30 min. from highway
• Legal Intercept/Privacy	➢ Roadblocks, search laws
• Emergency services	➢ Emergency lane, sirens
• Allocation of scare resources	➢ Parking space
• Interconnection pricing	➢ Tolls for highways
• Consistent use of names and addresses	➢ License plates, road numbers
• Minimum/guaranteed quality of service	➢ Safety standards/laws

Policy issues (2/4)

Generic issue	Example for roads
• Access for disabled	➢ Wheelchair ramps, audible traffic lights
• Directories	➢ Registry of motor vehicles
• Control of dominant players (national matter)	➢ Imposed highway price
• Consumer protection (national matter)	➢ Driving laws, vehicle safety laws
• Content control (national matter, not ITU)	➢ Dangerous goods transport

Policy issues (3/4)

- Question is:
  - Who sets policies?
  - By what methods?
- At:
  - National level
  - International level
- And:
  - Similar rules for similar services, or
  - Technology-specific rules?

(see http://www.itu.int/ITU-T/worksem/conreg/index.html)

More generally see: http://www.itu.int/ITU-T/special-projects/ip-policy/index.html

Policy issues (4/4)

- Saying "Technology X should be Y (e.g. free)" is merely one particular choice of policies
  - e.g. there should be no customs barriers or tolls on roads; or no universal access provision; or legal intercept
- Saying "Technology X should not be subject to national policy Y (e.g. excise tax)" is also merely one particular choice of policies
  - e.g. there should be no national control of certain aspects, for example national revenue collection for certain uses of the technology