Sieci Komputerowe

Ethernet i wirtualne sieci lokalne

mgr inż. Jerzy Sobczyk

Plan wykładu

- Technologia Ethernet.
- Wirtualne sieci lokalne VLAN
- Ethernet przemysłowy
- Kodowanie
- Połączenia kablowe

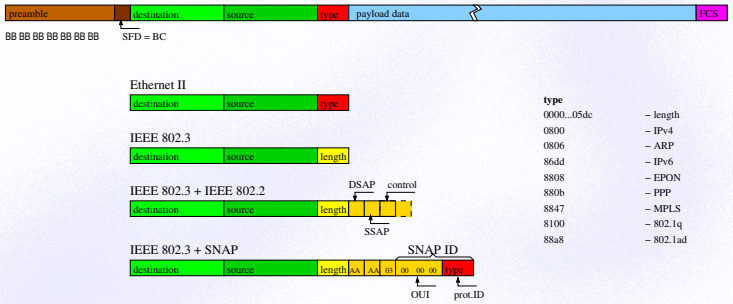
Historia

1968-1972	Sieć ALOHA - Norman Abramson
1973.5.22	Sieć Ethernet Bob Metcalf Xerox PARC
1977.12	US Patent 4,063,220
1979-1983	Digital Intel Xerox
1980	DIX Ethernet I - Blue Book
1981	Metcalf zakłada 3Com
1982	Ethernet II
1983	IEEE 802.3 10Base5
1984	IEEE 802.3 10Base2
1986	IEEE 802.3 1Base5
1989	ISO 88023 = IEEE 802.3
1990	IEEE 802.3i 10BaseT
1992	de-facto Fast Ethernet
1995	IEEE 802.3u 100BaseTX Fast Ethernet
1996	prop. Gigabit Ethernet
1998	IEEE 802.3z 1000BaseSX/LX/CX Gigabit Ethernet
1999	IEEE 802.ab 1000BASET
2000	10 GEA
2001	draft IEEE 802.3ae/D2.3
2001	100 Gigabit Ethernet - pierwsze eksperymenty
2002	standard IEEE 802.3ae 10GBase-SR,LR,ER,LX4,SW,LW,EW
2004	standard IEEE 802.3ah GEPON (Gigabit Ethernet Passive Optical Network)
2006	standard IEEE 802.3an 10GBase-T
2009	standard IEEE 802.3av 10G-EPON
2013	standard IEEE 802.3bk Extended EPON
2016	standard IEEE 802.3bz 2.5GBase-T, 5GBase-T

Metody dostępu do medium

Nazwa polska	Nazwa angielska	Przykłady zastosowania
Przepytywanie	Polling.	SNA, IEEE-488, IEC-625, HP-IB, GPIB.
Dostęp z przekazywaniem znacznika	Token Passing.	Token Ring, Arcnet, FDDI, CDDI, IEEE 802.5
Dostęp jednoczesny z wykrywaniem kolizji	Carrier Sense, Multiple Access with Collision Detect – CSMA/CD.	Ethernet, IEEE 802.3
Dostęp jednoczesny z unikaniem kolizji	Carrier Sense, Multiple Access with Collision Avoidance – CSMA/CA.	ApleTalk, WiFi

Rodzaje nagłówków ramki w sieci Ethernet



Ethernet

Standard	Kabel	Szybkość	Odległość	Uwagi
10Base5	Thick Coax RG8	10 Mb/s	500 m	Manchester, szyna
10Base2	Thin Coax RG58	10 Mb/s	185 m	Manchester, szyna
1Base5	CAT3 UTP	1 Mb/s	500 m	Manchester
10Broad36	Coax 75 Ohm	10 Mb/s	1800 m	Manchester, szyna
10BaseT 802.3i	CAT3 UTP	10 Mb/s	100 m	Manchester
10BaseF	MMF	10 Mb/s	2 km	Manchester

BNC

RJ45

LC

Fast Ethernet

Standard	Kabel	Szybkość	Odległość	Uwagi
100BaseTX 802.3u	CAT5 UTP	100 Mb/s	100 m	MLT-3 = NRZI-3
100BaseT4	CAT3 UTP	100 Mb/s	100 m	NRZI 8b/6t 4 pary
100BaseFX	SMF	100 Mb/s	20 km	NRZI 4b/5b
100VG-AnyLAN 802.12	CAT3 UTP	100 Mb/s	100 m	demad priority, NRZ 5b/6b

Gigabit Ethernet

Standard	Kabel	Szybkość	Odległość	Uwagi
1000BaseSX 802.3z	MMF 62.5μ	1 Gb/s	220-275 m	NRZI 8b/10b
	MMF 50μ	1 Gb/s	550 m	(850 nm)
1000BaseLX 802.3z	SMF 9.0μ	1 Gb/s	5000 m	NRZI 8b/10b
	MMF 50μ	1 Gb/s	550 m	(1300 nm)
	MMF 62.5μ	1 Gb/s	550 m	
1000BaseLX10 802.3ab	SMF 9.0μ	1 Gb/s	10 km	
1000BasePX10 802.3ah	SMF (1310 nm)	1 Gb/s	10 km	EPON split 1:16
1000BasePX20 802.3ah	SMF (1310 nm)	1 Gb/s	20 km	EPON split 1:16
1000BasePX30 802.3bk	SMF (1310 nm)	1 Gb/s	20 km	EPON split 1:32
1000BasePX40 802.3bk	SMF (1310 nm)	1 Gb/s	20 km	EPON split 1:64
1000BaseCX 802.3z	Twinax 150 Ohm	1 Gb/s	25 m	NRZI 8b/10b
1000BaseT 802.3ab	CAT5/6 UTP	1 Gb/s	100 m	4D-PAM5 NRZI

10 Gigabit Ethernet

Standard	Kabel	Szybkość	Odl.	Uwagi
10GBaseSW	MMF (850 nm)	9.953 Gb/s	65 m	SONET
10GBaseSR	MMF (850 nm)	10 Gb/s	300 m	
10GBaseLR	SMF (1310 nm)	10 Gb/s	10 km	
10GBaseLW	SMF (1310 nm)	9.953 Gb/s	10 km	SONET
10GBaseER	SMF (1550 nm)	10.3 Gb/s	40 km	
10GBaseEW	SMF (1550 nm)	9.953 Gb/s	40 km	SONET
10GBaseLX4	MMF (1310 nm)	12.5 Gb/s	300 m	CWDM-4
	SMF (1310 nm)	12.5 Gb/s	10 km	CWDM-4
1000BasePRX10 802.3av	SMF (1310 nm)	10.3/1.25 Gb/s	10 km	10G-EPON split 1:16
1000BasePRX20 802.3av	SMF (1310 nm)	10.3/1.25 Gb/s	20 km	10G-EPON split 1:16
1000BasePRX30 802.3av	SMF (1310 nm)	10.3/1.25 Gb/s	20 km	10G-EPON split 1:32
1000BasePRX40 802.3bk	SMF (1310 nm)	10.3/1.25 Gb/s	20 km	10G-EPON split 1:64
1000BasePR10 802.3av	SMF (1310 nm)	10.3 Gb/s	10 km	10G-EPON split 1:16
1000BasePR20 802.3av	SMF (1310 nm)	10.3 Gb/s	20 km	10G-EPON split 1:16
1000BasePR30 802.3av	SMF (1310 nm)	10.3 Gb/s	20 km	10G-EPON split 1:32
1000BasePR40 802.3bk	SMF (1310 nm)	10.3 Gb/s	20 km	10G-EPON split 1:64

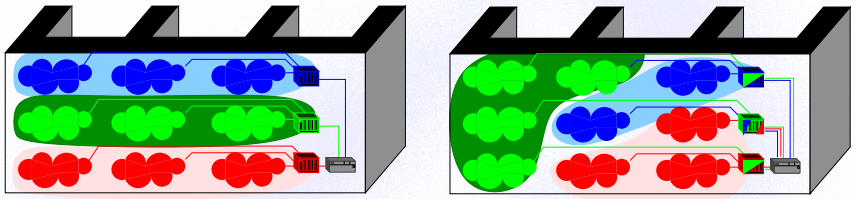
2.5 ... 40 Gigabit Ethernet

Standard	Kabel	Szybkość	Odl.	Uwagi
2.5GBaseT	UTP Cat.5E	2.5 Gb/s	100 m	
5GBaseT	UTP Cat.6	5 Gb/s	100 m	
10GBaseCX4	Twinax	10 Gb/s	15 m	
10GBaseKX4 10GBaseKR	backplane	10 Gb/s	1 m	
10GBaseT	UTP Cat.6A	10 Gb/s	100 m	
	UTP Cat.6	10 Gb/s	55 m	
25GBaseT	UTP Cat.8	25 Gb/s	30 m	
40GBaseT	UTP Cat.8	40 Gb/s	30 m	

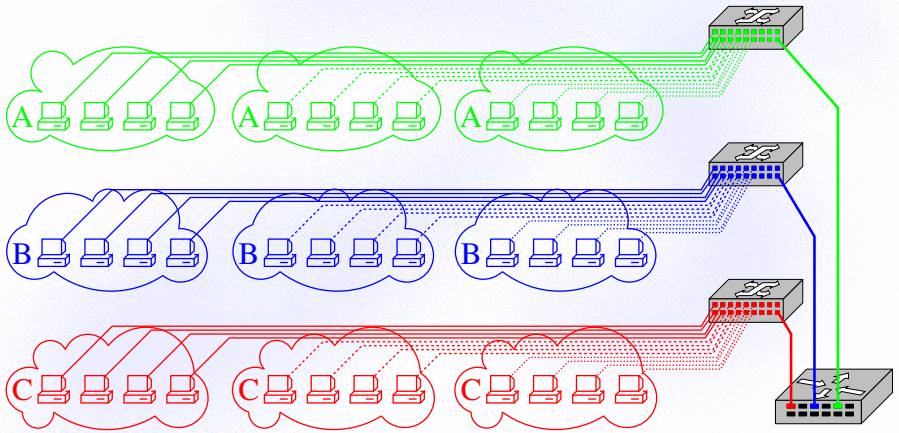
100 Gigabit Ethernet

Standard	Kabel	Szybkość	Odl.	Uwagi
100GBaseCR4 802.3bj	Twinax balanced	100 Gb/s	5 m	
100GBaseSR4 802.3bm	MMF (850 nm)	100 Gb/s	70-100 m	
100GBaseDR 802.3cd	SMF (1310 nm)	100 Gb/s	500 m	
100GBaseLR4 802.3ba	SMF (1310 nm)	100 Gb/s	10 km	WDM NRZ
100GBaseER4 802.3ba	SMF (1310 nm)	100 Gb/s	40 km	WDM NRZ

Routing vs. VLAN

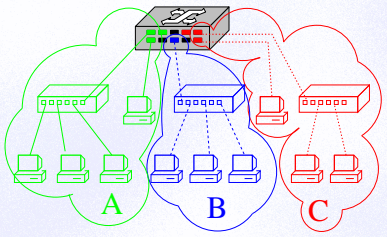


Routing VLANów - zwykły routing



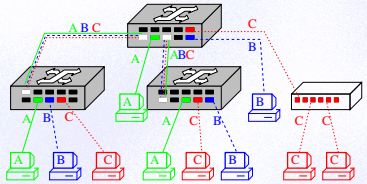
Routing VLANów - wiele mniejszych urządzeń

VLAN - port based

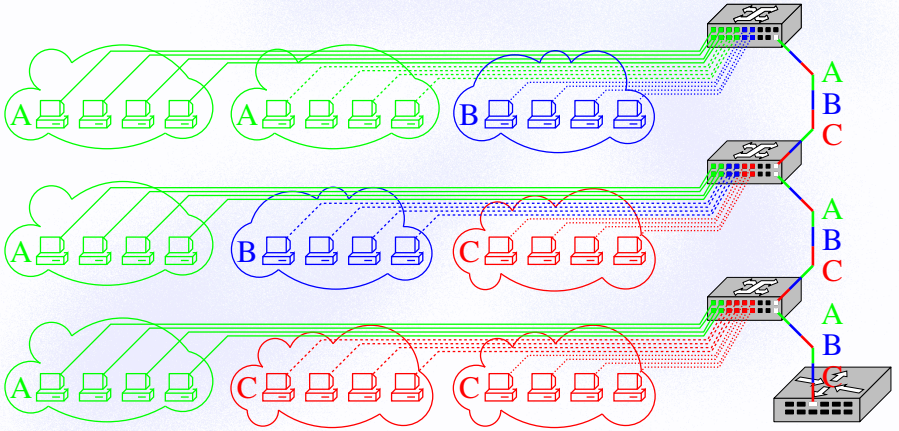


Routing VLANów - partycjonowanie przełączników

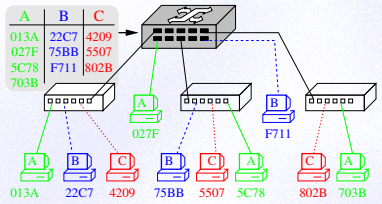
VLAN - tagged



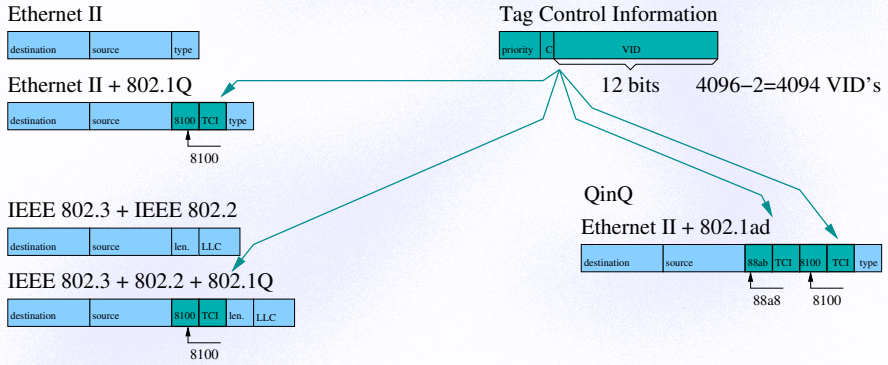
Routing VLANów - znakowanie



VLAN - MAC based

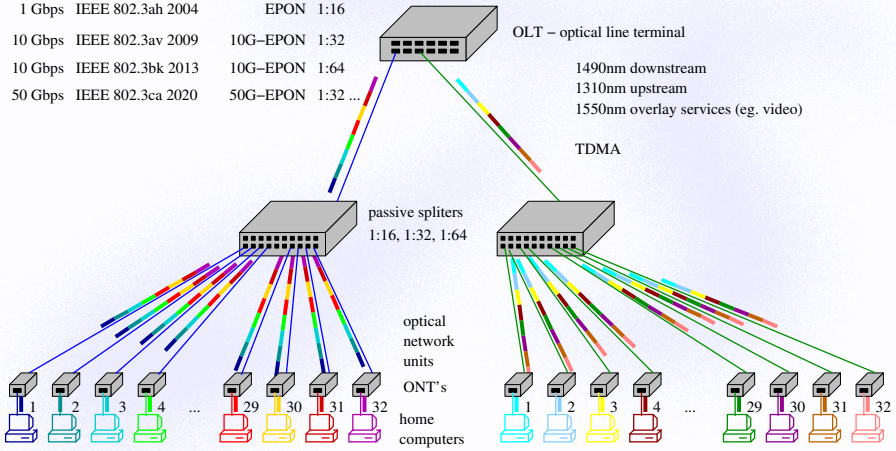


VLAN - 802.1Q and 802.1ad tagging



EPON and 10G-EPON

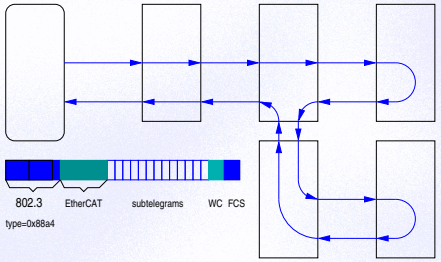
1 Gbps	IEEE 802.3ah 2004	EPON	1:16
10 Gbps	IEEE 802.3av 2009	10G–EPON	1:32
10 Gbps	IEEE 802.3bk 2013	10G–EPON	1:64
50 Gbps	IEEE 802.3ca 2020	50G–EPON	1:32 ...



Ethernet przemysłowy

Protokół	Uwagi
EtherCAT	ring, ether type 0x88a4, 100 Mbps
EtherNET/IP	any Ethernet, TCP port 44818, UDP port 2222
PROFINET	any Ethernet
SERCOS III	ether type 0x88cd,
CC-Link IE	1 Gbps
Modbus TCP	TCP port 502

EtherCAT



Połączenia kablowe

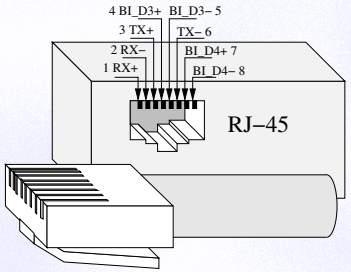
100BaseTX

Desktop (RJ45)	Hub (RJ45)	Opis
1, 2	1, 2	→ Transmit
3, 6	3, 6	← Receive

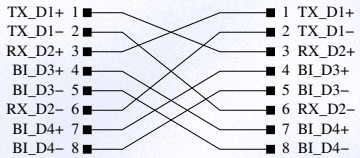
100BaseT4

Desktop (RJ45)	Hub (RJ45)	Opis
1, 2	1, 2	→ Transmit
3, 6	3, 6	← Receive
4, 5	4, 5	↔ Bidirectional
7, 8	7, 8	↔ Bidirectional

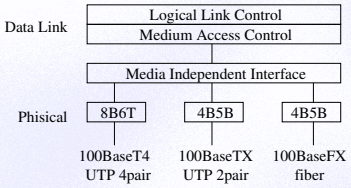
Okablowanie UTP T4



UTP T4 - kabel skrzyżowany



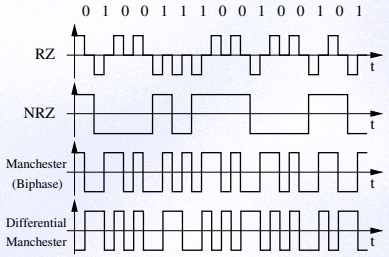
Fast Ethernet



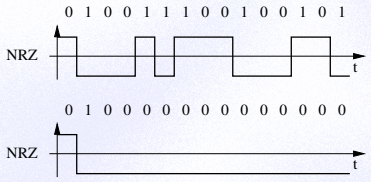
Autodetekcja szybkości - priorytety

A	100Base-TX Full duplex
B	100Base-T4
C	100Base-TX
D	10Base-T Full duplex
E	10Base-T

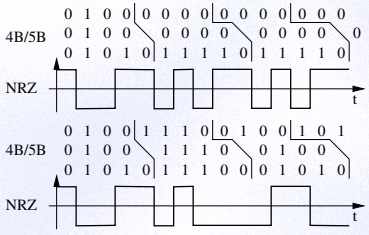
Encoding methods



Danger of NRZ



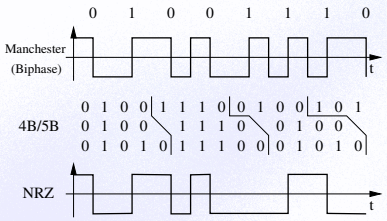
NRZ - safeguards



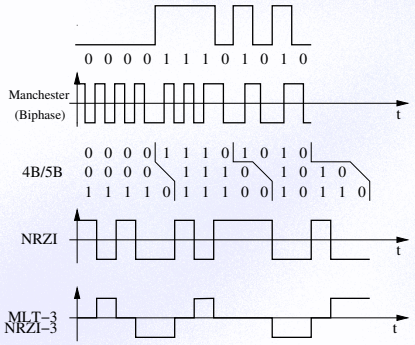
4B/5B Encoding

4-bit	5-bit	4-bit	5-bit
0000	11110	1000	10010
0001	01001	1001	10011
0010	10100	1010	10110
0011	10101	1011	10111
0100	01010	1100	11010
0101	01011	1101	11011
0110	01110	1110	11100
0111	01111	1111	11101

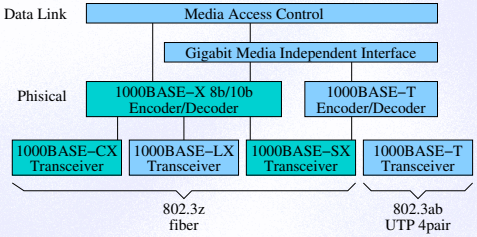
Manchester — NRZ 4B/5B



Kodowanie MLT-3 = NRZI-3



Gigabit Ethernet



Dziękuję za uwagę

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