ÇEV 361
Coğrafi Bilgi Sistemleri ve Uzaktan Algılama

Uzaktan Algılamada Çözünürlük Kavramı

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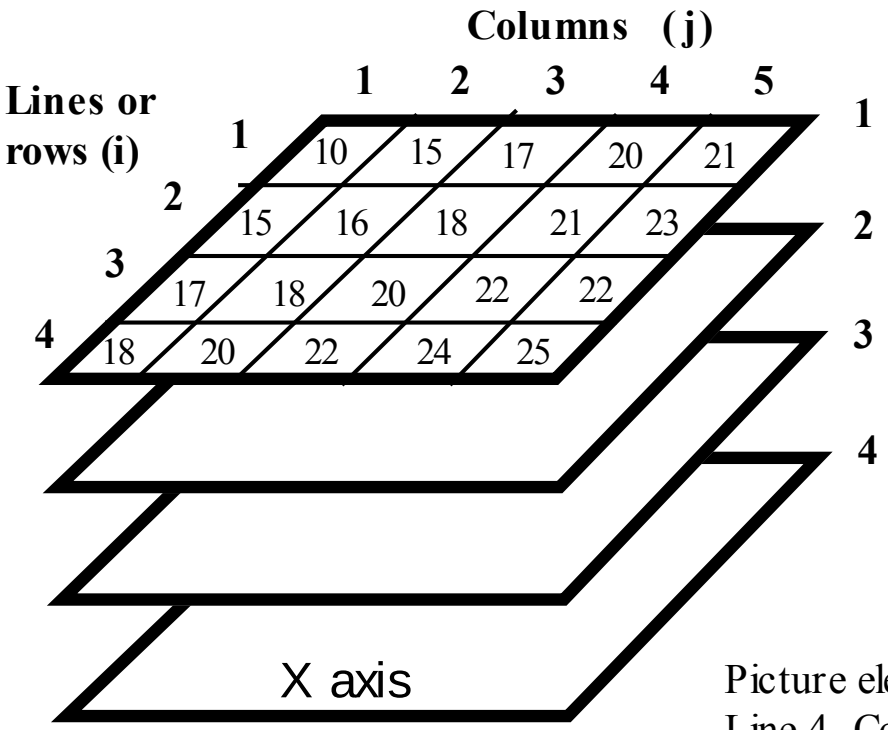
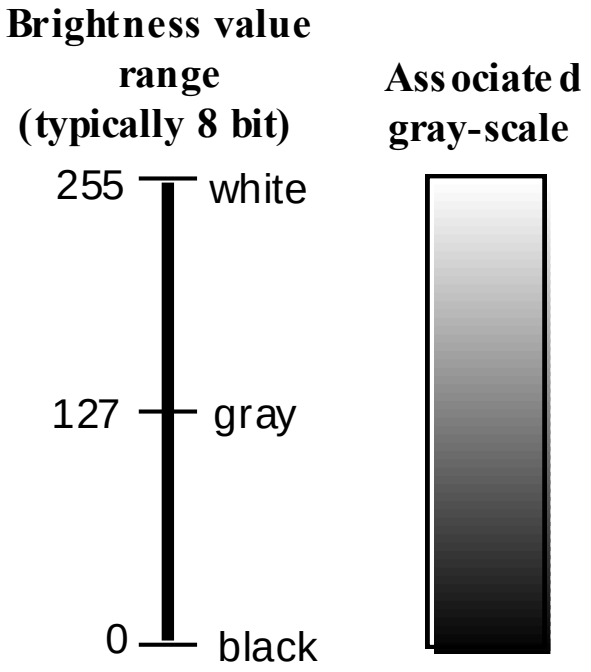
http://www.ozgurzeydan.com/

Uzaktan Algılama Verisi

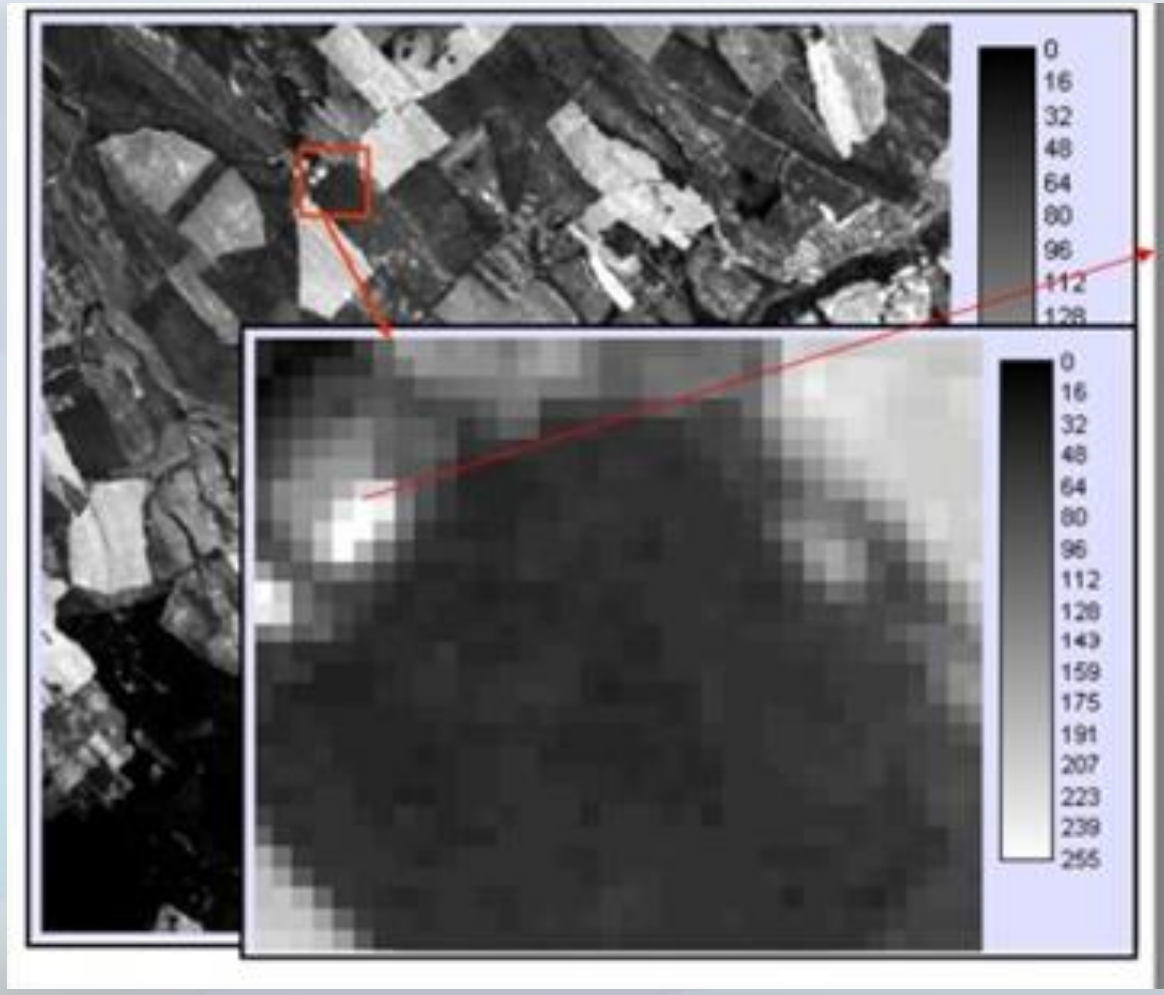
Raster Veri Formatı





Picture element (pixel) at location Line 4, Column 4, in Band 1 has a Brightness Value of 24, i.e., $BV_{4,4,1} = 24$.

Uzaktan Algılama Verisi



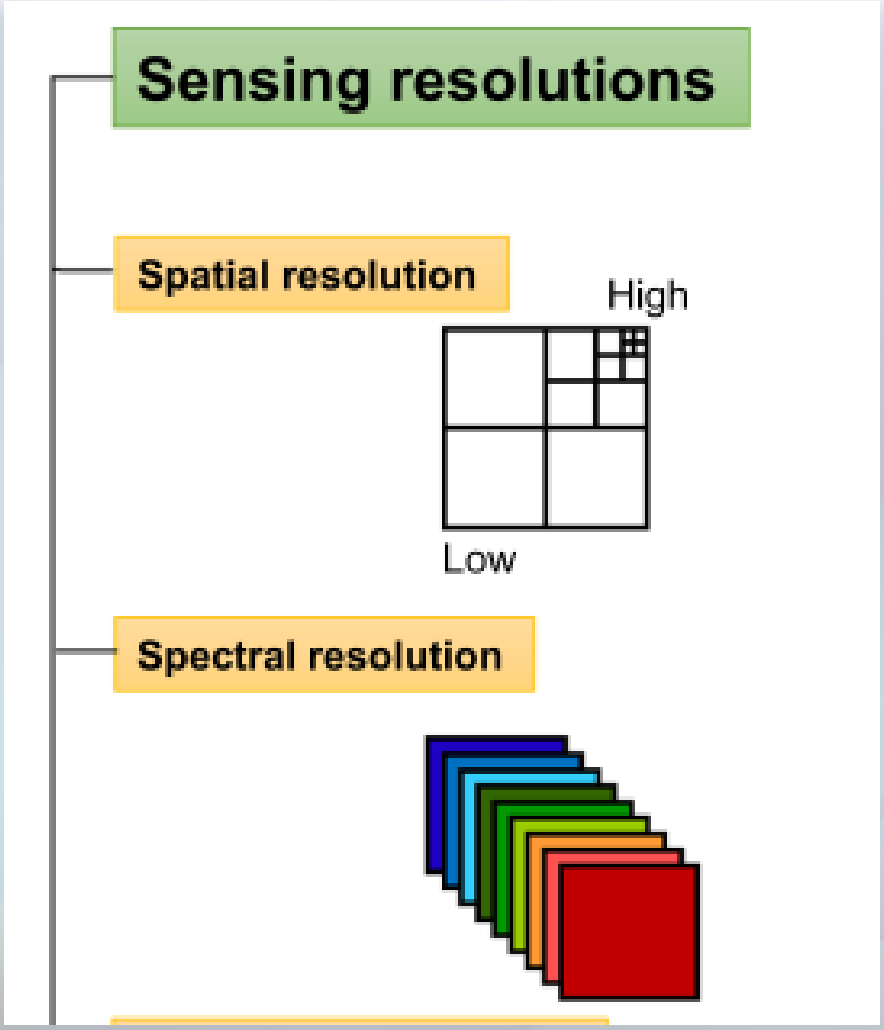
174	212	212	114	81	
228	225	239	125	43	
255	255	185	108		
255	179				

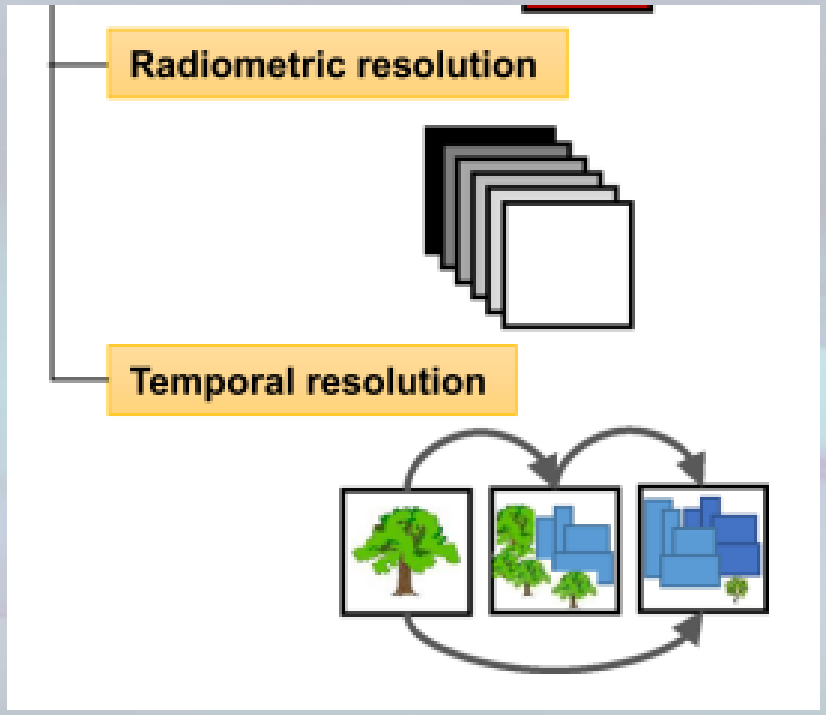
http://www.tankonyvtar.hu/hu/tartalom/tamop425/0027_DAI6/ch01s03.html

Uzaktan Algılama Verilerinde Çözünürlük

1. Mekansal (Spatial) Çözünürlük
   - Objelerin ayırt edilebilirliği
2. Spektral (Spectral) Çözünürlük
   - Spektral bant sayısı
3. Radyometrik (Radiometric) Çözünürlük
   - Verinin parlaklık değerindeki ayrıntı
4. Zamansal (Temporal) Çözünürlük
   - Verinin kaç günde bir toplandığı

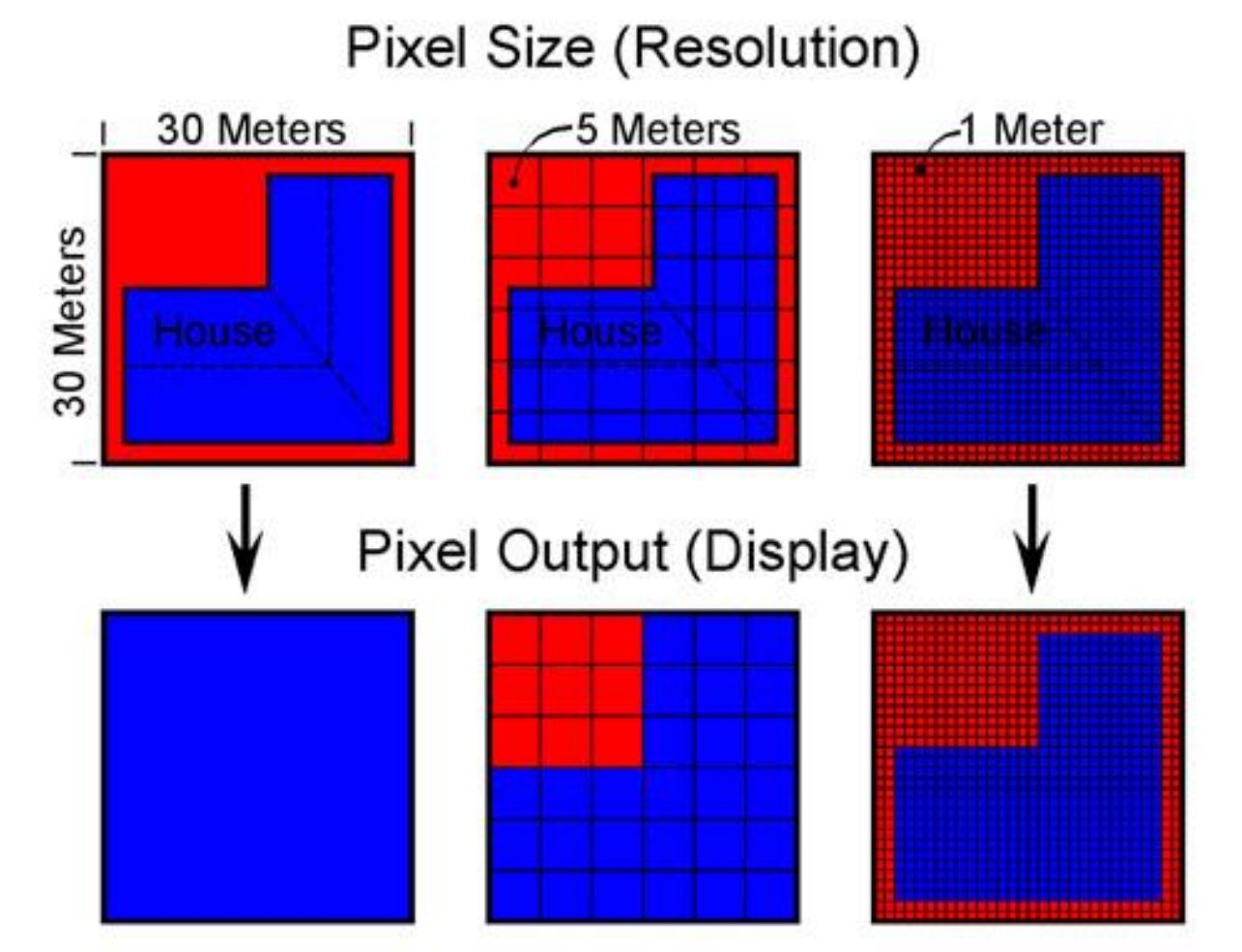
Uzaktan Algılama Verilerinde Çözünürlük





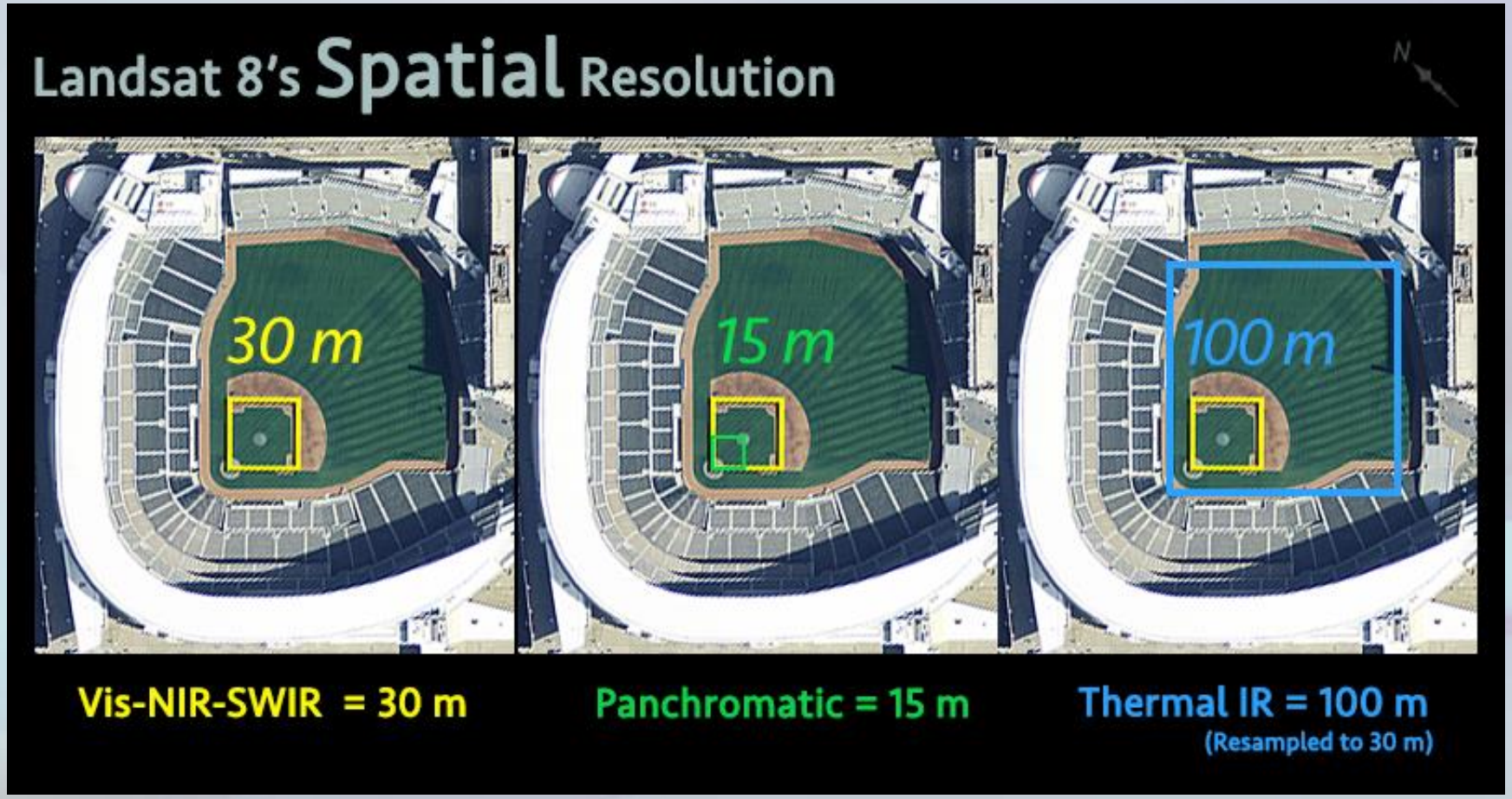
https://doi.org/10.1007/s41207-016-0007-4

Mekansal Çözünürlük

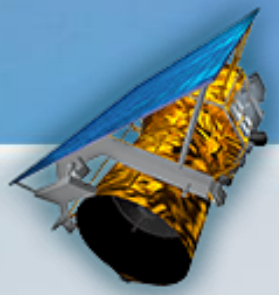


http://www.satimagingcorp.com/services/resources/characterization-of-satellite-remote-sensing-systems/

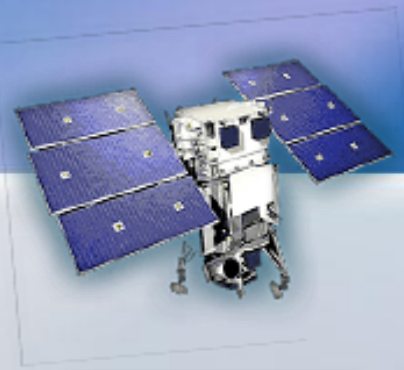
Mekansal Çözünürlük



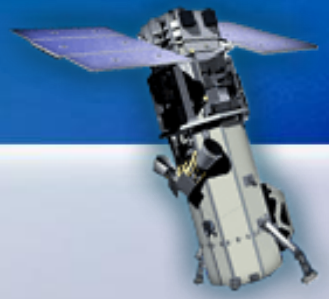
https://landsat.gsfc.nasa.gov/satellites/landsat-8/



GEOEYE-1 SHD
(0.41m)



WORLDVIEW-1 SHD
(0.46m)

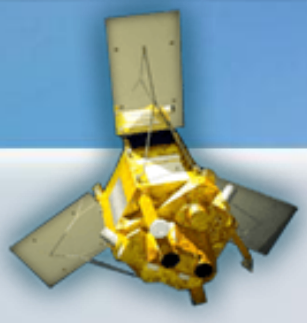


WORLDVIEW-2 SHD
(0.46m)

PLEIADES-1A SHD
(0.5m)

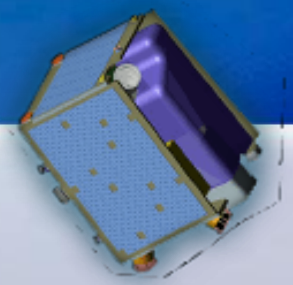
QUICKBIRD SHD
(0.61m)

IKONOS SHD
(0.82m)



SPOT-6 HD
(1.5m)

SPOT-5 HD
(2.5m/5m)



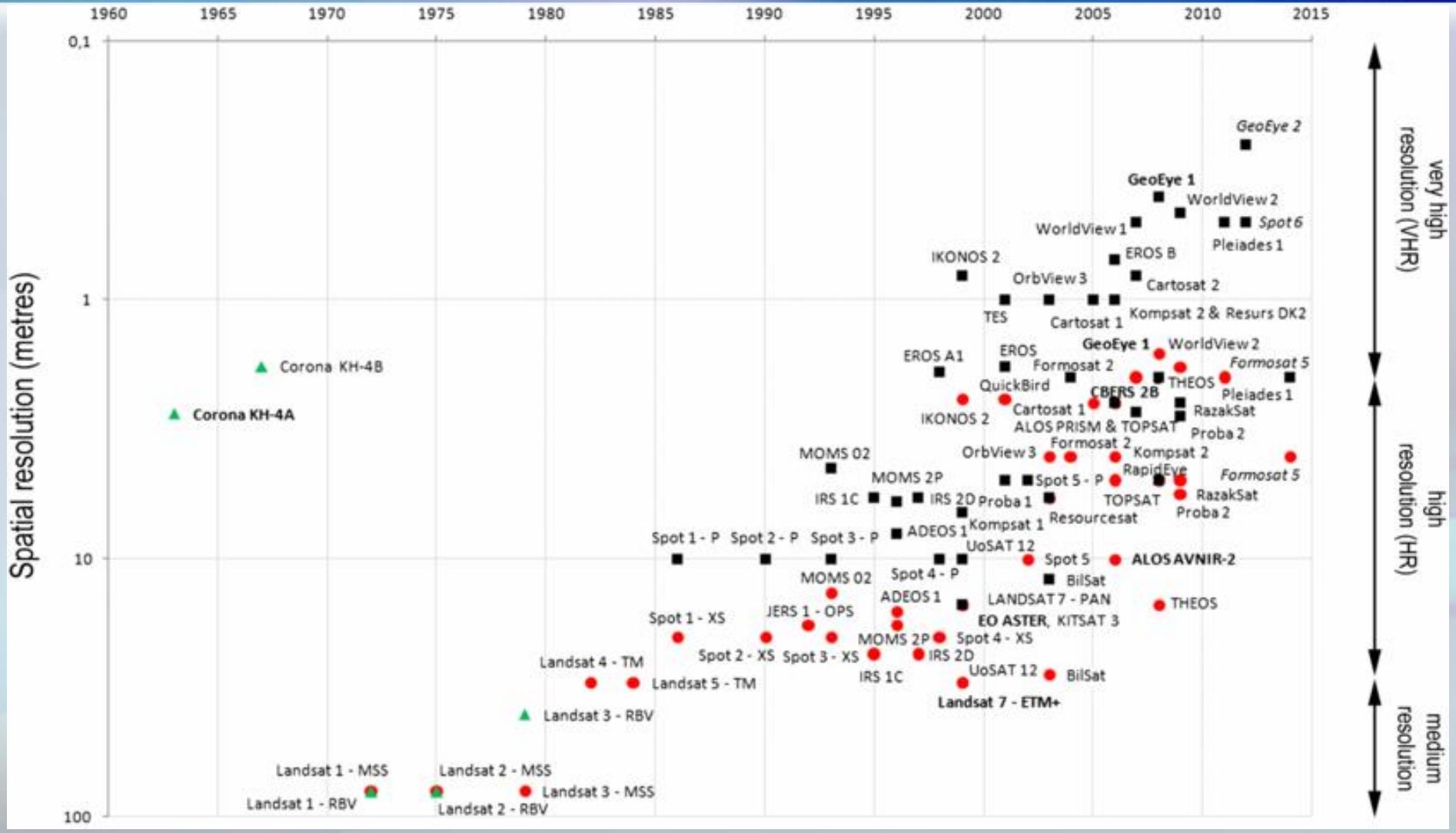
RAPIDEYE HD
(5m)

ASTER MED
(15m)

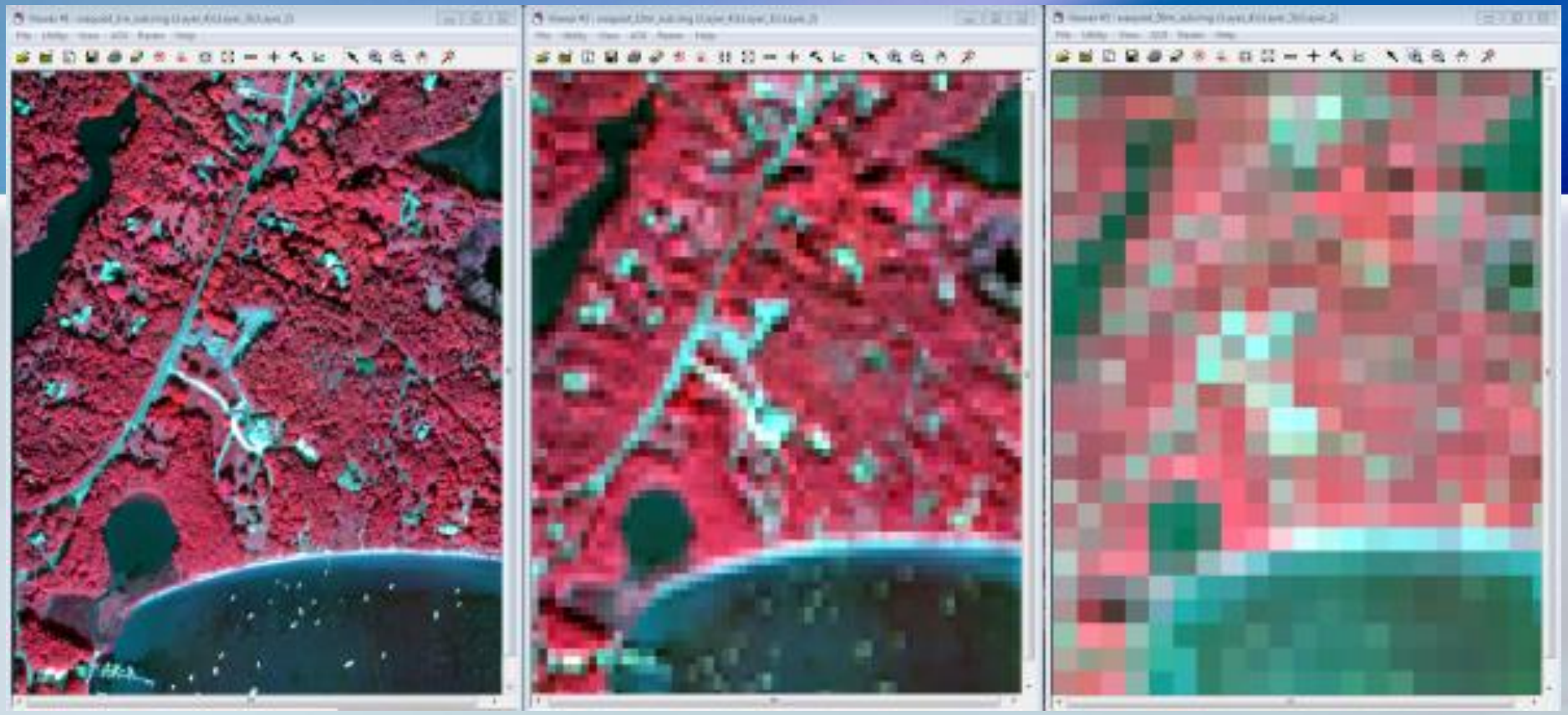
LANDSAT 7 +ETM MED
(30m)

http://www.satimagingcorp.com/services/resources/characterization-of-satellite-remote-sensing-systems/

Uydular ve Mekansal Çözünürlükleri



http://ej.iop.org/images/1742-2140/9/4/S40/Full/jge422698f3_online.jpg



NAIP aerial imagery in its native 1m format (left) compared to a 10m (middle) and 30m (right) version of the same data. While visual differences are easy to see, the file sizes also change from 2.5MB to 39kB to 23kB.

http://coast.noaa.gov/geozone/you-say-you-want-high-resolution/#.VH3LvnvIDhA

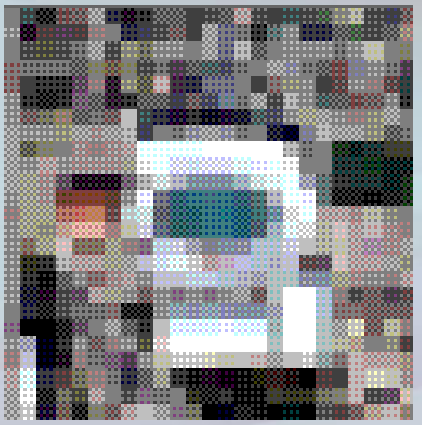
Mekansal Çözünürlük

1 m çözünürlük

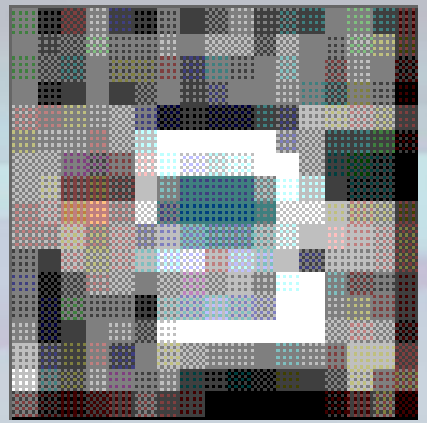
2 m çözünürlük

5 m çözünürlük

10 m çözünürlük



20 m çözünürlük

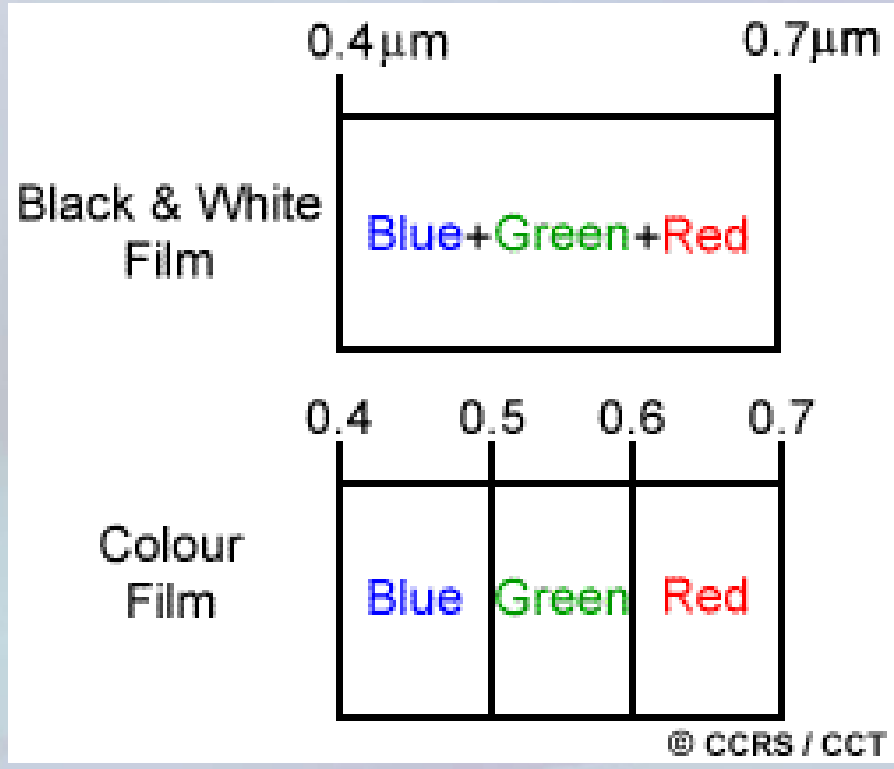


30 m çözünürlük

http://www.jmu.edu/cisr/research/sic/rs/resolution.htm

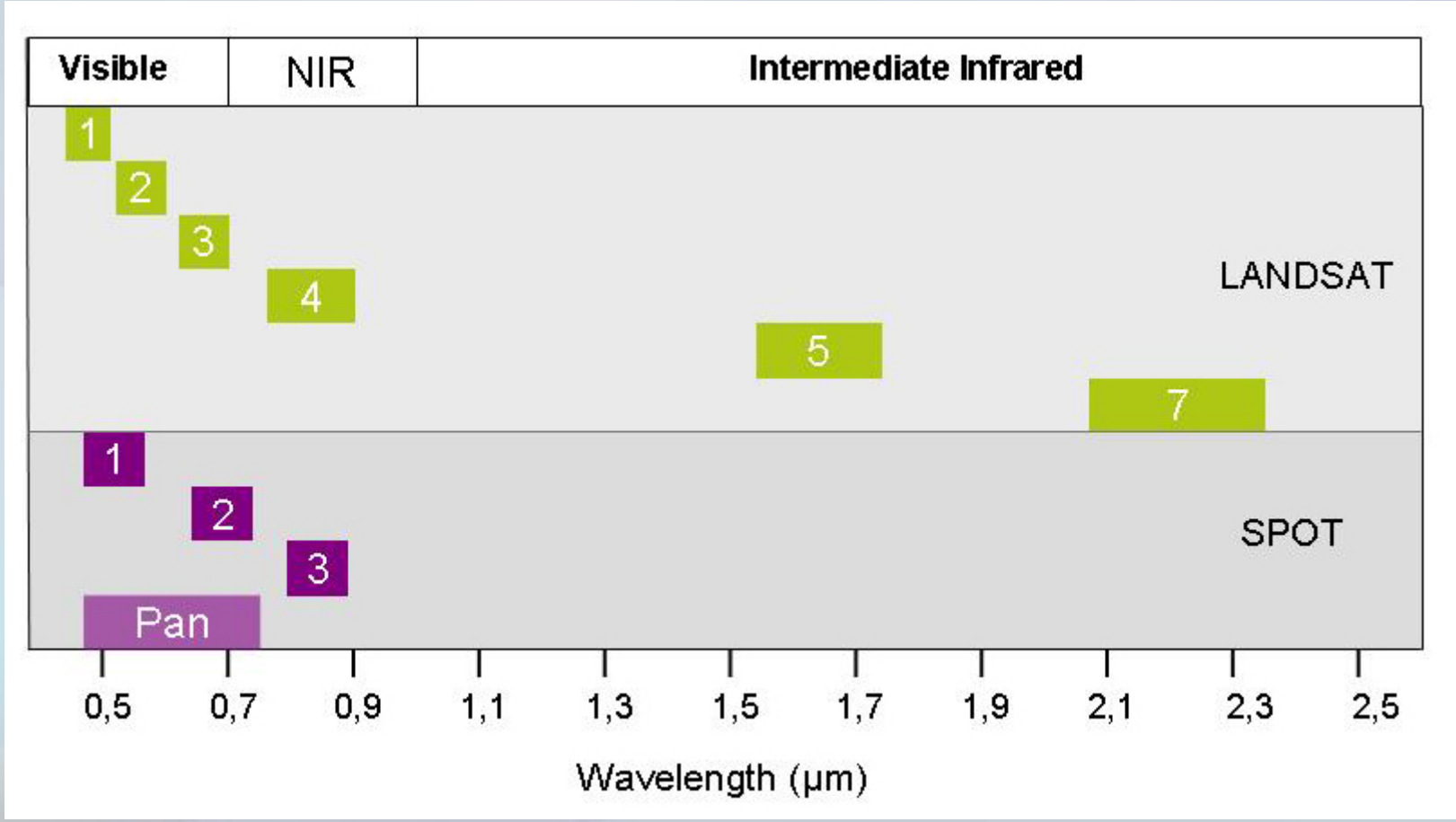
Spektral Çözünürlük

- Sensörün farklı dalga boylarında görüntü alabilme yeteneğidir.
- Spektral çözünürlüğün yüksek olması, belirli bir banttaki dalga boyunun daha dar olarak görüntülenmesi ile ilişkilidir.



http://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/satellite-imagery-products/educational-resources/9393

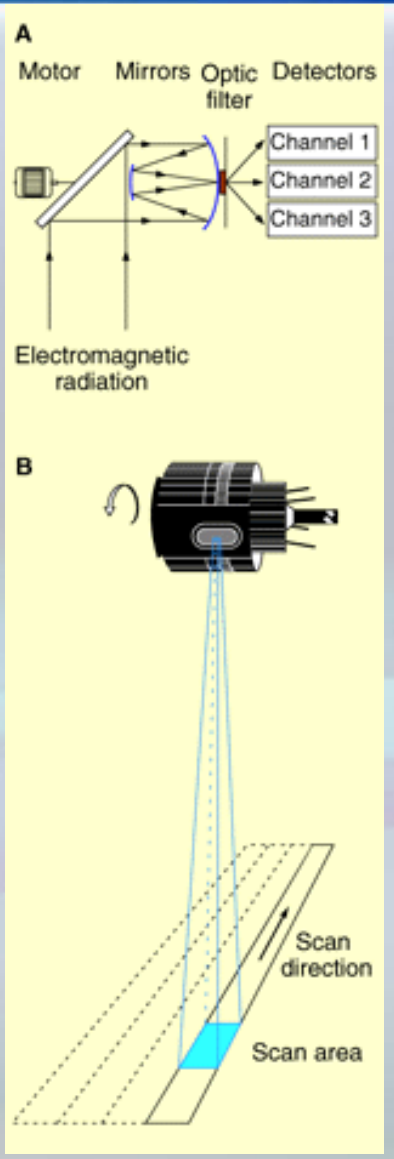
Spektral Çözünürlük



http://www.seos-project.eu/modules/remotesensing/remotesensing-c03-p03.html

Spektral Çözünürlük

- Yüksek: ~ 220 bant
- Orta: 3 - 15 bant
- Düşük: ~ 3 bant



Radyometrik Çözünürlük

- EMR'deki enerji farklılıklarını ortaya çıkarabilmenin ölçüsüdür.
- Yüksek radyometrik çözünürlükte EMR'deki enerji değişimleri daha iyi algılanır.

2-bit

8-bit

http://www.nrcan.gc.ca/earth-sciences/geomatics/satellite-imagery-air-photos/satellite-imagery-products/educational-resources/9379

Radyometrik Çözünürlük

- 1-bit (2^1): 0 $\rightarrow$ 1
- 4-bit (2^4): 0 $\rightarrow$ 15
- 8-bit (2^8): 0 $\rightarrow$ 255

Bits	Werteumfang	Grauwerte
1Bit	$2^1 = 2$ (0-1)	0 … 1
4Bit	$2^4 = 16$ (0-15)	0 … 15
8Bit	$2^8 = 256$ (0-255)	0 … 255

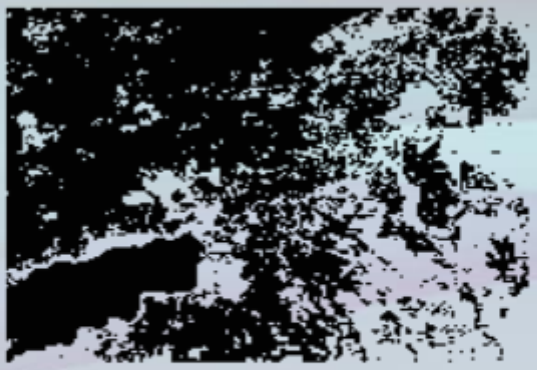
http://www.fis.uni-bonn.de/en/recherchetools/infobox/professionals/resolution/radiometric-resolution

Radyometrik Çözünürlük

16 Values (4 bit)

8 Values (3 bit)

4 Values (2 bit)



2 Values (1 bit)

http://commons.wikimedia.org/wiki/File:Decreasing_radiometric_resolution_from_L7_15m_panchromatic.svg

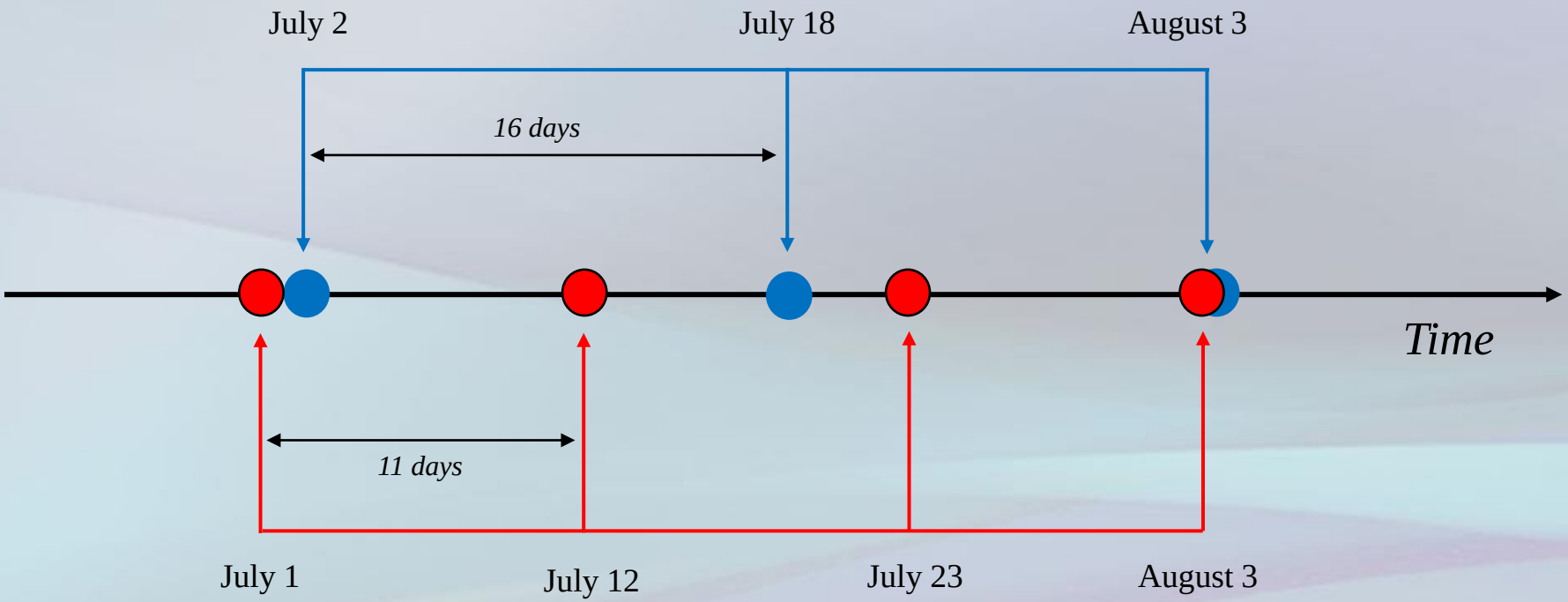
Zamansal Çözünürlük

- Sensörün aynı bölgeden kaç günde bir görüntü aldığının ölçüsüdür.

- Daha sık görüntü alınması yüksek zamansal çözünürlüğün göstergesidir.

- Yüksek : < 24 saat - 3 gün
- Orta : 4 - 16 gün
- Düşük: > 16 gün

Zamansal Çözünürlük



TÜBİTAK UZAY

Uzay Teknolojileri Araştırma Enstitüsü

- Yer Gözlem Uyduları:
  - Bilsat
  - Rasat
  - Göktürk-2

RASAT Araştırma Uydusu

TEKNİK ÖZELLİKLER	
Türk Yer Gözlem Uyduları	RASAT
Ağırlık	93 kg
Yörünge	689 km'de dairesel, güneşe eşzamanlı
Yönelim kontrolü	3 eksen kontrollü
Yörünge süresi	98.8 dakika
Ekvator geçişi yerel zamanı	10:30
Uzamsal çözünürlük	Pankromatik: 7.5 m Çok bantlı: 15 m
Tahmini ömür	3 yıl
Tayfsal çözünürlük (µm)	0.42 – 0.73 (Pankromatik) 1. Bant: 0.42 – 0.55 (Mavi) 2. Bant: 0.55 – 0.58 (Yeşil) 3. Bant: 0.58 – 0.73 (Kırmızı)
Radyometrik çözünürlük	8 bit
Zamansal çözünürlük	4 gün
Şerit genişliği	30 km
Faydalı yükler	• Optik faydalı yük: Stereoskopik görme özelliğine sahip Pushbroom görüntüleyiciden oluşmaktadır. • BiLGE: Spacewire veriyolu kullanabilen uçuş bilgisayarı. • GEZGiN-2: JPEG2000 algoritmaları ile yüksek hızda çok bantlı görüntü sıkıştırma ve şifreleme yapabilen yeni nesil görüntü işleme kartı. • X-Bant Verici Modülü: 100 Mb/s iletim hattına ve 7W çıkışa sahip iletişim sistemi.

http://uzay.tubitak.gov.tr/tr/uydu-uzay/rasat

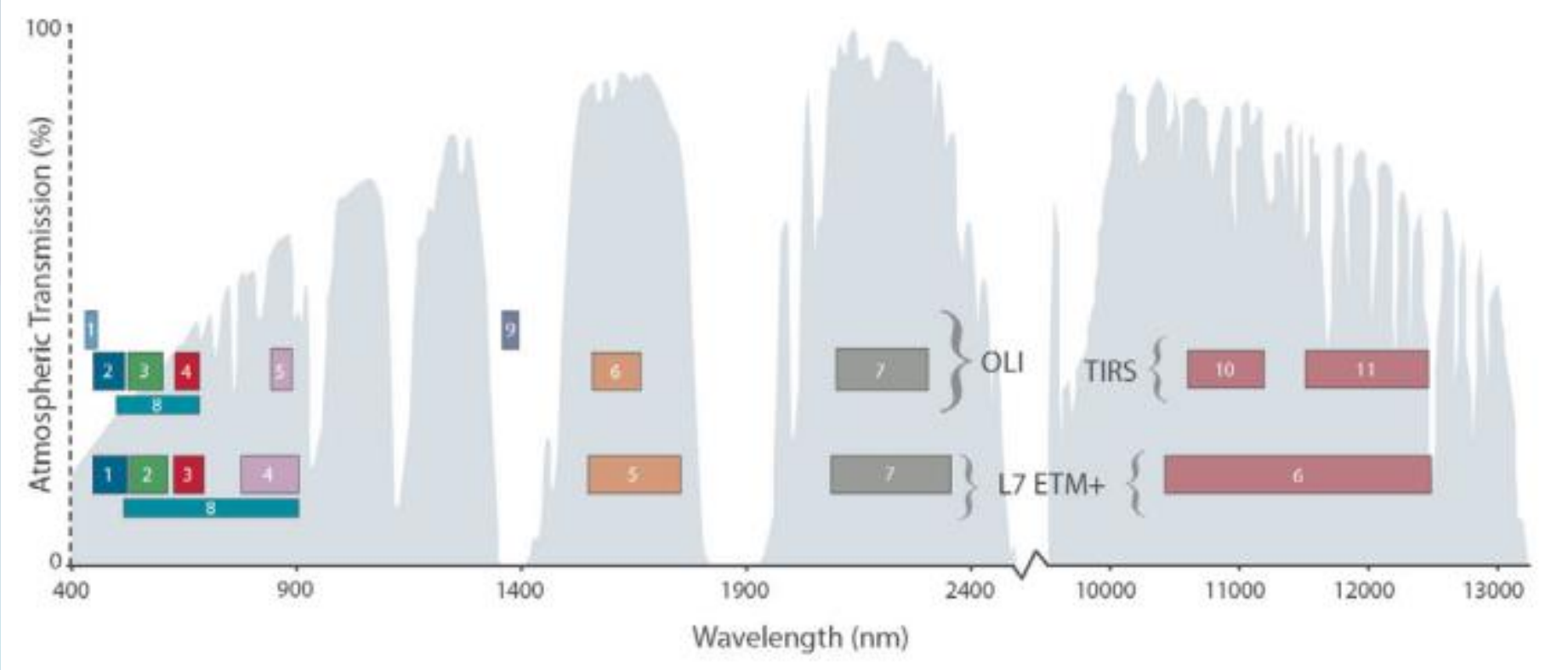
Landsat 7

Satellite	Scan Width (km)	Orbital Characteristics	Operation Period	Spectral Resolution (μm)	Band	Spatial Resolution (m)
Landsat 7	185	Orbital Altitude: 705 km, near polar, sun-synchronous Revisit Period: 16 days	**Landsat 7** 15/04/1999 -	**ETM+** Band 1: 0.450 – 0.515 Band 2: 0.525 – 0.605 Band 3: 0.630 – 0.690 Band 4: 0.760 – 0.900 Band 5: 1.550 – 1.750 Band 6†: 10.40 – 12.5 Band 7: 2.080 – 2.35 Band 8: 0.52 – 0.92	 Blue Green Red Near IR Mid IR Thermal Mid IR Pan	 30 30 30 30 30 60 30 15

Landsat 8

Landsat-7 ETM+ Bands (µm)			Landsat-8 OLI and *TIRS* Bands (µm)		
			30 m Coastal/Aerosol	0.435 - 0.451	Band 1
Band 1	30 m Blue	0.441 - 0.514	30 m Blue	0.452 - 0.512	Band 2
Band 2	30 m Green	0.519 - 0.601	30 m Green	0.533 - 0.590	Band 3
Band 3	30 m Red	0.631 - 0.692	30 m Red	0.636 - 0.673	Band 4
Band 4	30 m NIR	0.772 - 0.898	30 m NIR	0.851 - 0.879	Band 5
Band 5	30 m SWIR-1	1.547 - 1.749	30 m SWIR-1	1.566 - 1.651	Band 6
Band 6	60 m TIR	10.31 - 12.36	*100 m TIR-1*	*10.60 – 11.19*	Band 10
			100 m TIR-2	*11.50 – 12.51*	Band 11
Band 7	30 m SWIR-2	2.064 - 2.345	30 m SWIR-2	2.107 - 2.294	Band 7
Band 8	15 m Pan	0.515 - 0.896	15 m Pan	0.503 - 0.676	Band 8
			30 m Cirrus	1.363 - 1.384	Band 9

Landsat 7 vs 8



GeoEye-1

	Altitude 681 km
Orbit	Type: Sun-synchronous, 10:30 am descending node Period: 98 min
Sensor Resolution and Spectral Bandwidth	Panchromatic: 41 cm GSD at nadir Black & White: 450 - 800 nm Multispectral: 1.65 m GSD at nadir Blue: 450 - 510 nm Green: 510 - 580 nm Red: 655 - 690 nm Near-IR: 780 - 920 nm
Dynamic Range	11-bits per pixel
Swath Width	Nominal Swath Width: 15.3 km at nadir
Attitude Determination and Control	Type: 3-axis Stabilized Star tracker/IRU/reaction wheels, GPS
Retargeting Agility	Time to slew 200 km: 20 sec
Onboard Storage	1 Tbit capacity
Communications	Payload Data: X-band 740/150 Mbps AES/DES encryption Housekeeping: X-band 64 kbps AES encryption
Revisit Frequency (at 40°N Latitude)	2.6 days at 30° off-nadir
Metric Accuracy	5 m CE90, 3 m CE90 (measured)
Capacity	350,000 km^2/day Multi-spectral

IKONOS

Spatial resolution	Panchromatic: 0.82 m Multispectral: 3.2 m
Positional accuracy	15 meter CE90 (specification) 9 meter CE90 (measured)
Swath width	11.3 km
Off-nadir imaging	Up to 60 degrees
Dynamic range	11 bits per pixel
Revisit time	Approximately 3 days
Orbital altitude	681 km
Nodal crossing	10:30 am
Collection capacity	240,000 km^2/day (Pan + MSI)

QuickBird

	Altitude 400 km	Altitude 450 km
Orbit	Type: Sun synchronous, 10:00 am descending node Period: 92.4 min.	10:25 am descending node Period: 93.6 min
Sensor resolution and spectral bandwidth	Panchromatic: 55 cm GSD at nadir Black & White: 405 - 1053 nm Multispectral: 2.16 m GSD at nadir Blue: 430 - 545 nm Green: 466 - 620 nm Red: 590 - 710 nm Near-IR: 715 - 918 nm	Panchromatic 61 cm GSD at nadir Multispectral 2.44 m GSD at nadir
Dynamic range	11-bits per pixel	
Swath width	Nominal Swath Width: 14.9 km at nadir	Nominal swath width: 16.8 km at nadir
Attitude determination and control	Type: 3-axis Stabilized Star tracker/IRU/reaction wheels, GPS	
Retargeting agility	Time to slew 200 km: 37 sec	38 sec
Onboard storage	128 Gb capacity	
Communications	Payload Data: 320 Mbps X-band Housekeeping: X-band from 4,16 and 256 Kbps, 2 Kbps S-band uplink	
Revisit frequency (at 40°N Latitude)	Revisit time may vary from 2 to 12 days depending on target location as the orbit decays.	
Metric accuracy	23 m CE90, 17 m LE90 (without ground control)	
Capacity	200,000 sq km per day	

SPOT

Sensor-system	Spectral resolution (µm)	Spatial resolution (m)	Scan-width (km)	Revisit period	Orbital altitude	Operation periode
HRV	channel 1: 0,50 - 0,59	20×20	60	26 days / variable	832 km, near polar, sun-synchronous	21/02/1986 -
	channel 2: 0,61 - 0,68					
	channel 3: 0,79 - 0,89					
	Panchromatic: 0,51 - 0,73	10×10	117			

Uydular Hakkında Daha Detaylı Bilgi İçin Web Kaynakları:

- http://www.nik.com.tr/content_sistem_uydu_goruntuleri.asp
- http://www.satimagingcorp.com/satellite-sensors/
- http://www.esa.int/SPECIALS/Eduspace_EN/SEM7YN6SXIG_0.html
- https://eospso.nasa.gov/