Essl 290 2021

Lecture 33

Today: HW 5pm

Weds: Barnett Ch13

Standardizing time worldwide

Increased communications and connectivity via transportation networks revealed inefficiencies in the system of local times that existed in Europe and North America in the early 19th century. These pressures led to national systems of standardized time in:

1) Great Britain (effective 1855, legislated 1880)
2) United States (effective 1883, legislated 1918)
3) Canada (effective 1883)

The standardized time in these countries was indexed to Greenwich Mean Time in the sense that the resulting time zones differed from Greenwich by whole numbers of hours.

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However, during this period many European countries used a national railroad time indexed to time in one of their principal cities:

France - small offset from Paris time (5min) longitude 2.35° E ~> 9.4 min ahead

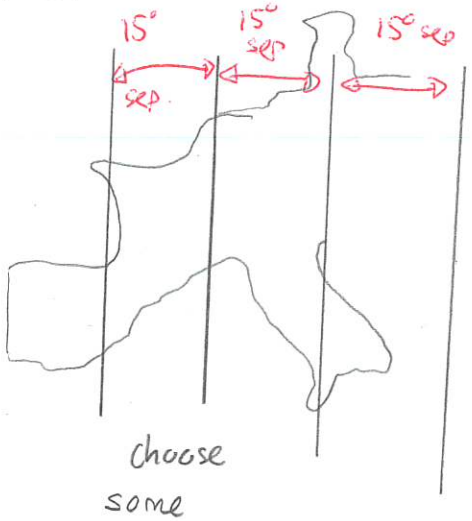
Belgium - Brussels time longitude 4.35° E ~> 17.40min ahead

Germany - Berlin 13.4° E ~> 53.6 min ahead of Greenwich
Munich 11.6° E ~> 46.4 min " " "
Stuttgart

These unusual time differences would have had little bearing on most peoples lives except if they happened to travel into or communication with people in other regions.

The situation could have been simplified if there were agreement on two things:

1) a choice of one meridian on which to anchor time.



Choose some meridian as "prime"

Then if the time at that prime meridian is known, the time at meridians 15° away would differ by 1hr

30° " " " 2hrs etc,...

2) a way of allocating time zones based on such meridians. for example a band which spans 15° centered on the meridian would have a single time.

The issue of a single prime meridian would also be important for navigation. Prior to the 1880s there was a proliferation of meridians in use.

Howse, 1884 and Longitude Zero, Vistas in Astronomy, Vol. 28, p11-19 (1985)

TABLE 1.

Prime meridians in use in the early 1880s on newly published maps and charts

Country	Prime meridian	
	Sea charts	Land maps
Austria	Greenwich	Ferro
Bavaria	——	Munich
Belgium	Greenwich	Brussels
Brazil	Greenwich and Rio de Janeiro	Rio de Janeiro
Denmark	Greenwich, Copenhagen and Paris	Copenhagen
France and Algeria	Paris	Paris
Germany	Greenwich and Ferro	Ferro
Holland	Greenwich	Amsterdam
India	——	Greenwich
Italy	Greenwich	Rome
Japan	Greenwich	Greenwich
Norway	Greenwich and Christiania	Ferro and Christiania
Portugal	Lisbon	Lisbon
Russia	Greenwich, Pulkowa, and Ferro	Ferro, Pulkowa, Warsaw, and Paris
Spain	Cadiz (S. Fernando)	Madrid
Sweden	Greenwich, Stockholm and Paris	Ferro and Stockholm
Switzerland	——	Paris
UK and colonies	Greenwich	Greenwich
USA	Greenwich	Greenwich and Washington

Sources - Sea charts: BORSARI, F., *Il meridiano iniziale e l'ora universale* (Napoli, 1883), 60. Land maps: WHEELER, G.M., *Report on the Third International Geographical Congress...Venice...1881* (Washington, 1885), 30.

In the early 1870s, two Americans were strongly arguing for a uniform system of time - Charles F Dowd, principal of a ladies' seminary in Saratoga Springs, N.Y., who devised the time-zone system used world-wide today, initially based on the Washington meridian, and who lobbied with the railroads for its adoption; and Professor Cleveland Abbe of Cincinnati Observatory who became first official weather forecaster for the US Government and argued strongly from a scientific standpoint.

In 1876, Sandford Fleming, Chief Engineer of the Canadian Pacific Railway, published a memoir called Terrestrial Time, which he proposed should be a uniform time used all over the world for railroads, telegraphs, science, etc. He suggested also that an hour-zone system similar to Dowd's should be used for domestic purposes. He read two papers in Toronto in 1878-9, "Time-reckoning", similar to his 1876 paper, and "Longitude and time-reckoning" suggesting a prime meridian 180 degrees from Greenwich. The British government thought these so important that in June 1879 they forwarded copies to eighteen foreign governments and to various scientific bodies in England.

This was the initial motivation for settling on a single choice of prime meridian that would anchor the world's systems of longitude and standardized time.

Howse

Beyond navigation, other important factors were:

1) scientific work - observations done simultaneously from different locations

2) geodesic work - mapping using longitude

3) telegraphic communications - the Atlantic cable was completed in 1857

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Demo: Submarine Cable Network

1 Telegraphic Communications

Several people in different locations communicate via telegram with each other. Maria is in Madrid (longitude 3.70° W), Larry is in London (longitude 0°), Alice in Amsterdam (longitude 4.90° E) and Roberto is in Rome (longitude 12.496° E). Each uses a local time based on a meridian passing through his or her longitude.

Telegram Number	From	To	Arrival Time (Local)	London
1	Maria	Roberto	2:15pm	1:25pm
2	Roberto	Alice	1:40pm	1:20pm
3	Alice	Larry	1:30pm	1:30pm
4	Larry	Maria	1:20pm	1:35pm

We want to establish the order in which the telegrams were sent. Recall that a longitude difference of 1° corresponds to a difference of 4min in local time.

a) List the telegrams in order of their arrival.

b) Did you use one particular meridian as a reference to do the listing?

c) If you used a different meridian as a reference would the order of the listing change?

d) What would the advantages and disadvantages be of using one particular meridian to list the times of arrival?

a) Convert everything to London time using 1° ~ 4min.

Madrid ~ 3.70° x 4min = 14.8 min behind London ≈ 15 min

Ams ~ 4.90° x 4min = 19.6 min ahead of London ≈ 20min

Rome ~ 12.496 x 4min = 50min ahead of London

So 2:15pm Rome ~ 1:25pm London

1:40pm Ams ~ 1:20pm London

1:20pm Mad ~ 1:35pm London

So order from earliest to latest: 2, 1, 3, 4.

b) Yes, in this case London

c) No, the numbers in the converted times differ

d) * pros: easier to order events

* cons: need to agree on Meridian

The process by which the world's system of measuring longitudes and times was resolved was:

1876 - 1879 Sanford Fleming (Canadian Pacific Railroad)
* promotes the idea of a prime meridian
* promotes the idea of 24 time zones, differing from each other by 1 hour

↓

generally favorable reaction except from a few astronomers (Airy, Smyth)

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1881 3rd International Geophysical Congress
* considerable discussion

↓

Various proposals for prime meridian:
Greenwich, Pyramids of Egypt, Jerusalem, Bering Strait

↓

1883 7th International Geophysical Congress (Rome)
* series of resolutions recommending adoption of Greenwich as prime meridian.

↓

1884 International Meridian Conference (Washington)
* government representatives meet to resolve meridian issue.
* formally endorse Greenwich observatory as the meridian 0°

Almanac Office in an invited address, strongly backed the latter view.

What seems to have broken the deadlock was the presentation by Sandford Fleming of Table 2, showing the number and total tonnage of vessels using the several meridians for finding longitude. He summed up the table as follows: "It thus appears that one of these meridians, that of Greenwich, is used by 72% of the whole floating commerce of the world, while the remaining 28% is divided among ten initial meridians. If, then, the convenience of the greatest number alone should predominate, there can be no difficulty in a choice; but Greenwich is a national meridian...". He then went on to advocate his 1879 proposal that Greenwich plus 180 degrees should be the zero for longitude and time. Passing through the Pacific, it could be thought of as neutral. Fleming's proposal was not adopted but the table he presented in its favour had a great influence on the final decision.

Sir William Thomson, though not himself a delegate, summed up the feelings of many of them: "It cannot be said that one meridian is more scientific than any other, but it can be said that one meridian is more convenient for practical purposes than another, and I think that this may be said pre-eminently of the meridian of Greenwich..."

TABLE 2.

The various prime meridians in use on charts in 1883
and the proportion of ships that used them

Initial meridians	Ships of all kinds		Percent	
	Number	Tonnage	Ships	Tonnage
Greenwich	37,663	14,600,972	65	72
Paris	5,914	1,735,083	10	8
Cadiz	2,468	666,602	5	3
Naples	2,263	715,448	4	4
Christiania	2,128	695,988	4	3
Ferro	1,497	567,682	2	3
Pulkowa	987	298,641	1½	1½
Stockholm	717	154,180	1½	1
Lisbon	491	164,000	1	1
Copenhagen	435	81,888	1	½
Rio de Janeiro	253	97,040	½	½
Miscellaneous	2,881	534,569	4½	2½
Total	57,697	20,312,093	100	100

So at last, in the afternoon of October 13 1884, the vote on Resolution II was taken. There was 22 ayes, 1 no (Santo Domingo), and 2 abstentions (Brazil and France). (Santo Domingo, or the Dominican Republic, had recently come under the dictatorship of Ulises Heureaux, who was presumably trying to make a mark in international circles.) The conference had chosen Greenwich as the world's prime meridian, though it must be made clear that this was merely a recommendation to the various governments, not an absolute commitment.

Resolution III

"That from this meridian, longitude shall be counted in two directions up to 180 degrees, east longitude being plus and west longitude minus."

The Rome conference had proposed that longitude should be counted in a 360 degree notation from west to east, and Spain, for example, advocated this in Washington. Sweden, however, proposed

The resolution of this conference was not legally binding but it did establish a solid basis by which longitude an time zones could be organized.

The conference did establish more precise meanings for a day and also when it begins and starts.

Various countries adopted this in piecemeal fashion, typically setting time zones that differed from Greenwich by a whole number of hows, sometimes by half hows.

1888 Japan
1892 Belgium, Netherlands
1893 Italy, Germany, Austria - Hungary
⋮
1901 Spain
⋮
1911 France

The process was hastened by:

1) radio communications (starting 1899)
2) synchronizing war efforts / WW I

Demo: Wikipedia Time Zone Map
- anomalies 1) Spain on CET
2) France on CET
3) Netherlands on CET

Wikipedia - Time in Europe