Background Data: The Air War Game—Battle of Britain

Randy H. Katz
CS Division, EECS Dept.
University of California, Berkeley
Spring 2013

Background History

• May 1940: German Blitzkrieg in the West
  - German mechanized warfare shocks the Allies
  - Holland, Belgium fall in days, France defeated in 6 weeks
  - British Expeditionary Force (BEF) miraculously escapes at Dunkirk, leaving most of its equipment behind

• Operation Sea Lion: Germany poised to invade England
  - Triumphant Luftwaffe operates from airbases in Northern France through Norway
Air War Game
Early War Version

• Britain on defense
  - Defend on the sea and in the air

• Germany on offense
  - Neutralize the Royal Navy and soften the defenses in preparation for an amphibious assault against Southeastern England
Decisions Made in the 1930s

• Have the sides invested in the right technologies to achieve their goals?
  - Planes and pilots
  - Strategic vs. tactical capabilities
  - Offensive vs. defensive focus
  - Detection measures and countermeasures
  - Interception methods
### Battle of Britain: The Movie

![Battle of Britain Movie Poster](image)

### Planes vs. Planes

<table>
<thead>
<tr>
<th>Aircraft</th>
<th>HP</th>
<th>Max Speed</th>
<th>Climb</th>
<th>Range</th>
<th>Ceiling</th>
<th>Bomb Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hurricane IIC</td>
<td>1300</td>
<td>327 mph @ 18K ft</td>
<td>2750 ft/ min</td>
<td>460mi @ 175 mph</td>
<td>35K ft</td>
<td></td>
</tr>
<tr>
<td>Spitfire IA</td>
<td>1175</td>
<td>355</td>
<td>0-20K/9 min</td>
<td>575</td>
<td>34K</td>
<td></td>
</tr>
<tr>
<td>ME BF 109E</td>
<td>1175</td>
<td>348 @ 14.5 233 cruising</td>
<td>3510 ft/ min</td>
<td>410</td>
<td>36.5K</td>
<td></td>
</tr>
<tr>
<td>ME BF 110G</td>
<td>1100x2</td>
<td>349 250 cruising</td>
<td>0-19.6K/ 9.2 min</td>
<td>540</td>
<td>32K</td>
<td></td>
</tr>
<tr>
<td>JU 87D Stuka</td>
<td>1400</td>
<td>195 max 118 cruising</td>
<td>199</td>
<td>24K</td>
<td>3968 lbs</td>
<td></td>
</tr>
<tr>
<td>JU 88</td>
<td>1200x2</td>
<td>286 @ 16K 239 cruising</td>
<td>1553</td>
<td>26.5K</td>
<td>5510</td>
<td></td>
</tr>
<tr>
<td>DO 17z</td>
<td>1000x2</td>
<td>265 @ 16.5 236 @ 14.5</td>
<td>745 1860 (tanks)</td>
<td>26.7K</td>
<td>2200 1100</td>
<td></td>
</tr>
<tr>
<td>HE 111</td>
<td>1350x2</td>
<td>270 @ 19.6</td>
<td>1212 760 (loaded)</td>
<td>27.9K</td>
<td>Up to 5500</td>
<td></td>
</tr>
</tbody>
</table>
Radio Detection And Ranging

- Over the horizon detection
- Based on the principle of radio reflection

Fig. 7.1 The Principle of Radar. A powerful pulse of radiation transmitted by the radar antenna induces electric currents in the target. These currents in turn radiate a pulse, but very much weaker, and scattered in all directions. Some of this scattered radiation returns to the radar antenna, which now functions as a receiving antenna. The time between the transmission and return of the pulse measures the target range. The return pulse is only detected when the radar is "looking" at the target.
**Chain Home vs. Chain Home Low**

<table>
<thead>
<tr>
<th>Chain Home</th>
<th>Chain Home Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>30 MHz, 10m waves, 125 mi range @ 15-20,000 ft</td>
<td>200 MHz, 1.5m waves, 40 mi range 5000 ft alt.</td>
</tr>
</tbody>
</table>

Shorter wavelengths, higher frequencies, greater precision in ranging
Rotating antenna for better directional accuracy
Suitable for night interception

**Plate 7.1** Chain Home. Chain Home provided the world’s first strategic air defence radar network, erected along the east and south coasts of Britain (later extended to the west coast). It used High Frequency and consequently demanded large installations. 360-foot-high transmitter masts are seen on the left of the photograph above and 240-foot receiver masts on the right. (Photo: By courtesy of GEC-Marconi)

**Fig. 8.1** Chain Home Low. Britain’s radar technology leaps forward from Chain Home to Chain Home Low (CHL), which became the most famous equipment during WW2. Working on the much higher frequency of 200 megahertz, it was compact and was mounted on rotating turntables to provide 360° scanning. It was mounted on 125-foot towers in short or cliff tops to improve performance against low-altitude intruders. Like Chain Home, CHL used bistatic information, a great change from ground-based surveillance out to sea, but prior to ground clutter masks and it remained clearly a coastal radar. CHL was the first radar to make ground-based control (interception, GCI) possible at night.

---

**Fig. 1.** Principles of CH (Chain Home) R.D.F. system
Ground Control Intercept

Fig. 7.2  **Forms of Radar Display**  On the left above, the ‘A’ scope, with a baseline corresponding to a fixed time interval. The transmitted pulse registers at the left, the returned echo showing as a ‘blip’ at some distance to the right – the distance being proportional to the range to the target. On the right, the ‘PPI’ (plan position indicator), in which the radar is at the centre of the display, which shows not only distance but the direction of the target. In this illustration, North is assumed to be at the top.

**Battle of Britain: British Command and Control System, 1940**

1. Radar station
2. Dowling, fighter command
3. Park, Number 1, group
4. Sector station
5. Observer Corps HQ

6. AAA (Army)
7. Observer post (constabulary)
8. barrage balloons
9. Land-line

Information
Information and orders
Information, launch orders

Intercept orders – radio
What Really Happened – Part I

The Luftwaffe concentrated on offensive reconnaissance during this period, attacking convoys in the Channel, RDF stations and the coastal towns in the planned Invasion area.

Phase 1 – July 10th to August 7th

What Really Happened – Part II

Having tested the defences, Phase 2 of the plan was to destroy the aircraft of Fighter Command, on the ground or in the air. The airfields of I1 Group in particular came in for heavy attacks.

Phase 2 – August 8th to 6th September
What Really Happened – Part III

Massed attacks began against London and other major cities, as well as aircraft factories and other strategic targets. As large numbers of fighters met the day raids, the Luftwaffe switched to night bombing.

Phase 3 - 7th September to October 5th

What Really Happened – Part IV

Heavy bomber raids against cities continued at night. During the day, fighter-bombers flew nuisance raids against coastal towns, airfields, and other military targets. The raids petered out as the weather worsened.

Phase 4 - 6th October to October 31st
Next Week: Strategic Bombing
Offensive vs. Germany

• Fighters vs. Bombers
  - What are good targets?
    • Strategic vs. tactical plans
  - Precision bombing
    • Daylight vs. nighttime raids, formation flying, escorts
    • Minimizing plane and crew losses while maximizing enemy destruction
  - How do you intercept attackers?
    • Where is the enemy? Radar to observe planes at a distance, searchlights to track plans nearby
    • How to confuse the defender as to attacker’s plans and intentions?
    • Getting the fighters to arrive at where you expect to the bombers to be